WORLD CROPS

THEIR CULTIVATION, PROTECTION, STORAGE, HANDLING AND PROCESSING FOR FOOD, FODDER, AND INDUSTRIAL PRODUCTS

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WORLD CROPS

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THIS MONTH'S COVER.—Where soil and sky conjunction make! A combine harvester reaps a rich reward from the rolling plains of Nebraska, U.S.A., and typifies the everlasting struggle to extract as much as possible from the soil while keeping it in good heart.

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Sir E. John Russell, F.R.S.

introduces 'World Crops'

THIS new Journal appears appropriately at a time when a great revolution is taking place in world agriculture. Hitherto the food producers have been almost a race apart ; self-contained in many ways, obtaining most of their requirements from their own or other peoples' land or from local craftsmen who produced implements and other appliances expressly for them. The large towns and cities have been in the main remote aggregates of people who have purchased the surpluses from the countryside and in return supplied consumer goods but only to a limited extent the appliances needed for actual food production. The outstanding exception has been the fertilisers which came from factories right outside the range of experience of the ordinary countryman, and, characteristically enough, met with a good deal of prejudice in consequence so that even today they are often called ' artificials ' in some sort of contradistinction to the ' natural ' manures that are not factory made.

SIR E. JOHN RUSSELL, O.B.E., D.Sc., F.R.S.
President of the British Association for 1949/50 and formerly Director of Rothamsted Experimental Station.

Today, however, the situation is rapidly changing. Tractors are displacing horses as the chief source of power on the farm, and for their most economic use they need their own implements specially designed for them, and not the older ones designed for horses. Like the tractors, these implements need high grade steel and fine machining, and only by mass production can they be supplied sufficiently cheaply for wide use ; and this, of course, means standardisation. No longer can each district have its special implements evolved by long experience as suited to the conditions and made by local craftsmen with traditions of good honest work and of service to their own community whose needs they knew. Instead we have the engineer design of general application but capable of some adjustment, mass produced by factory workers knowing and probably caring nothing of the ultimate use of their products ; working not locally but in the industrial regions of the Midlands and of the North. So, too, with the fertilisers, pest control agents, growth promoters, weed destroyers and others of the rapidly expanding list of aids to farm production resulting from the modern advances of science. These are not for local craftsmen to make ; they can be produced only by highly organised, extremely efficient and specialised industries.

The great agricultural developments of the 19th century were begun by pioneers with primitive appliances, not highly productive, often involving much hardship to the men, and particularly to the women. The developments now starting in the mid-20th century are being made with modern engineering and scientific appliances.

Post-war conditions have brought home to everyone the urgent need for a more and better organised food production. The need has long existed ; the world population has long been growing faster than new land has been brought into cultivation. The combination of science and engineering with agricultural practice can undoubtedly solve the problems of production, but success will require a close linkage between industry and agriculture, at least at the higher levels, and this will be greatly facilitated by the regular issue of an authoritative journal which can present the developments of modern agriculture to all technicians likely to be interested : agricultural, engineering, chemical and others. Fortunately the house of Leonard Hill, already well experienced in technological matters, has undertaken the task of issuing this Journal, and, equally fortunately, Sir Harold Tempany, a high expert in crop production in the Colonies, has agreed to become its first editor. Many will join with me in wishing the Journal and its producers all success in the important work that lies before them.

E J Russell

Editorial Comment . . .

World Agriculture and 'World Crops'

THE first number of WORLD CROPS appears when ideas concerning the future pattern of world agriculture are beginning to show signs of assuming definite shape.

In the first two years after the war it was generally assumed that the crisis shortage of agricultural produce would be of short duration, and that it would be rapidly overcome once peace had been re-established. It has only recently become clear that the shortage is likely to persist for a lengthy period and may even become permanent, unless effective steps are taken to deal with it.

Two main factors contributed to this shortage : (1) there has been under-estimation of the degree and the extent of war damage, and (2) populations are increasing at a rate never before paralleled. Other factors are the shift in some of the centres of production and the increasing degree of political independence throughout the world. On the other hand, ease of communication has led to a greater inter-dependence of production, and shortages at one point find their repercussion in other places which may be remote from them geographically.

Thus, a twofold task confronts the world comprising firstly the overtaking and repair of the damage and waste resulting from the war and secondly the progressive increase of production so that it may not only keep pace with the requirements of rapidly growing populations but also permit the raising of the standard of living of the vast sections in which admittedly it is too low. As the world is primarily dependent on agriculture, and industrial development is possible only when the workers have enough to eat, and as, moreover, improvement of living conditions, through what are usually termed social services, is only economically practicable when production is sufficient to pay for them, the solution of these two problems is vital to the existence of humanity.

The future

Opinion is to some extent divided as to the long-term outlook. By some it is felt that unless population increase can be effectively regulated, it may never be possible to secure a stable balance between production and ever-increasing needs. By others it is believed that the undeveloped resources of the world, and the possibilities of increased production from cultivated areas are so great that the problem can be surmounted and that for some generations to come the need for restricting population growth need not be paramount.

The difference seems to be one of degree of urgency since clearly with a limited total area there is also a limit to the population the earth is capable of carrying. Whichever school of thought is correct, however, there can be no question that increase in productivity is of pressing importance requiring concentration of effort similar to that devoted to destruction during the war period. Unfortunately destruction of the means of production, painfully built up over years, can be accomplished in a few hours or even minutes by war, but the replacement of the damage done may take years, and improvement in methods even longer.

The magnitude of the problem inspired the formation of the Food and Agriculture Organisation of the United Nations following the Conference at Hot Springs in 1944. Already F.A.O. has performed invaluable services in focusing attention on the problems of agriculture in their international aspect and, through its publications and conferences, in co-ordinating and disseminating essential information. There have been parallel activities in almost every country and it can truly be said that at no previous time have the needs of agriculture for official assistance and support been recognised to anything like the present extent. On the improvement of agricultural production the whole future of mankind is dependent, and the present provision is an eleventh hour recognition of the urgency of the need.

Recovery to date

Turning to the immediate outlook, recent reports show some encouraging signs ; it would, indeed, be remarkable were this not so, being given the extensive efforts to increase production now in progress in almost every country.

The position of course is largely influenced by the weather. So far as this is concerned, world prospects are, as a whole, not unfavourable.

The matter of most vital moment is, of course, increased production of food crops and here a few examples illustrate the progress made towards recovery. For major food crops recent estimates show that the combined world production of the major cereals, wheat, barley, oats, maize and rye will, in the current years, considerably exceed the pre-war production of 339,000,000 tons after having fallen considerably below it for a lengthy period. Similarly, rice production will probably equal and may exceed the average pre-war mondial

total of 101,000,000 tons. Oils and fats are expected to equal the pre-war production of 23,000,000 tons, while the pre-war world production of 30,000,000 long tons of raw sugar was approached in 1947-48 when it reached 29,000,000 tons and should be considerably exceeded during the current year.

These figures indicate considerable increases in production in certain localities, notably in the Western hemisphere; on the other hand, recovery in many parts of Europe and Asia has by no means yet reached the pre-war standard. Bearing in mind, therefore, that in the intervening period world populations have increased by some 200,000,000, and that in any case in the pre-war period there were large unsatisfied demands for food owing to lack of purchasing power, the present position gives small grounds for any degree of complacency.

The situation in regard to other crops is more complex. A record tea crop in India is offset by the fact that although production in Indonesia is showing marked signs of recovery it is still far below pre-war levels, while the full effect of blister blight disease in Ceylon is still to be gauged. Cocoa continues to be dominated by the disease threat in West Africa notwithstanding a sudden and unexpected increase in crops from that area as a result of new plantings and an exceptionally favourable season. Production of the various kinds of fibres is still below pre-war; shortages of Manila hemp have been partly made up by increased production of sisal in East Africa, while cotton crops are, on the whole, good.

An imponderable factor here is increasing competition from synthetic fibres. Synthetic substitutes dominate the situation in regard to rubber in a more intense degree. In Malaya, after four years' rest of the trees during the Japanese occupation, record yields have been obtained and for 1948 production in that country alone reached the unparalleled figure of 696,978 long tons. However, unless some agreement can be reached for regulating supplies of the synthetic and natural product in consonance with the demand it is hard to see how difficulties inseparable from overproduction can be avoided.

Against the increasing competition of synthetic substances can be set to some extent the interest that is developing in vegetable products as sources of new raw materials for industry, examples are carbohydrate waste materials such as cereal waste and bagasse from sugar cane as sources of furfural, alternative uses for natural rubber, production of vanillin from wood pulp and many others.

Increased mechanisation holds out the main hope of increasing production and lowering costs, especially under tropical conditions. The large scale operation in East Africa in the mechanised cultivation of groundnuts by the British Overseas Food Corporation is an outstanding example of this modern agricultural technique, and it is being paralleled by similar efforts in many other parts of the tropics. It has served to throw into relief many of the unforeseen problems and difficulties on the solution of which the future of mechanisation is largely dependent. Of interest also is the parallel undertaking of the Corporation in Queensland to cultivate sorghum, some account of which is given in this issue of WORLD CROPS.

In developing the resources of the tropics human and animal diseases are dominant problems. So long as diseases such as malaria and trypanosomiasis continue to be widespread the population cannot be fully efficient. Of outstanding significance, therefore, is the recent claim that it has been possible to eradicate malaria from Cyprus by the systematic spraying of D.D.T. A campaign with a similar objective has lately been inaugurated in Mauritius. In both these countries malaria has long been a scourge, and if the success so far achieved can be extended to other countries it may prove to be one of the greatest contributions to increased production, through greater efficiency, although it cannot be gainsaid that by removing yet another natural check to population increase it also enhances the demands made upon the land.

Conservation

Obviously, increased production must be coupled with effective steps to ensure that resources are conserved and fertility is not wasted. Soil erosion has been widely publicised of late as a dominant factor in this connection, and indeed, there is no question that it has been, and still is, responsible for greater losses than any other single cause. Its arrest and control are matters of supreme urgency, but one must always remember that erosion is a man-made disaster and not a natural phenomenon like a plant disease which generally can be combated only after it has appeared. The cure for erosion is quite simply correct land use and the duty of ensuring this devolves in the last resort on all governments. It is significant that a world conference on the Conservation of Natural Resources will take place this month at Lake Success under the auspices of the United Nations at which the many aspects of the question will be discussed.

Science has greatly enhanced the potential of agricultural production and on the practical application of science to agriculture in a still greater degree, recovery and future development depends.

One of the most difficult of the tasks confronting the world is the translation of the results of research into practice and the dissemination of knowledge concerning the results achieved. Indeed, it is now widely recognised that the task of explaining the results of research to the farmer and to the general public is every whit as important as the conduct of

research itself. Many media are being used for this purpose including the written word, the spoken word, pictorial representation and practical demonstration. Much of the super-abundant literature available deals with specialised aspects of research and there are few journals designed to convey its results in popular terms, giving at the same time an overall picture of world agriculture today. It is, of course, impossible for a single publication to cover this enormous field in detail. We feel, however, that there is a real place for a journal which seeks by careful selection to inform its readers of the major developments in agricultural science and technique, to interpret them and, where necessary, to criticise them, and furthermore, to do all this in language shorn as far as possible of technical terms. It is to this task that the publisher and editors of WORLD CROPS set their hand.

Chemistry and plant disease

COMING at a time when attention is being directed evermore strongly to the need for increasing food production and conserving and protecting supplies of foodstuffs, the 2nd International Congress of Plant Protection, held between July 20 and 30, ranks as an event of major significance. A summary of the proceedings appears elsewhere in this issue, but here we may comment on the astonishing strides made with the application of chemical and physical science to the control of pests and diseases of crops during the past decade.

In 1939 the range of material and methods available was still restricted ; true, there were signs of expansion, new substances and new techniques had already assumed some prominence, but the tempo was moderate and international discussions were usually confined to one or at most two sessions of the somewhat infrequent conferences on economic entomology and plant pathology.

The fact that it has now been possible to hold in London a Congress attended by 600 delegates from 29 countries at which some 90 papers dealing with aspects on plant disease control by chemical means were presented and discussed, is testimony to the developments that have occurred.

The war is, of course, mainly responsible, under the stress of military necessity new substances and new methods were applied to pest control, primarily it is true to those which threatened the safety of the military forces ; but the application of these to safeguarding crops is a post-war development. The chemists, the physicists, the biologists and the engineers have, indeed, metaphorically turned these weapons, if not into ploughshares, at least into insecticides, fungicides, crop-spraying and dusting machinery.

Almost weekly nowadays the chemist produces from his arcana new substances for the protection of crops. The physicist and the engineer not to be outdone turn out machines which subdivide material into ever finer and finer sprays and dusts, while the biologist indicates the most vulnerable points for attack on maladies and evaluates the results achieved by his collaborators. Together they invade new fields ; nowadays we have systemic insecticides which, when applied to the soil, penetrate the plant and poison attacking insects without affecting the plant itself ; chemotherapeutics which neutralise viruses and other diseases or stimulate the plant to resist their effects ; growth promoting substances which, in some concentrations, stimulate growth and in others destroy it. On the application side the tractor, the aeroplane and the helicopter have all been enlisted ; there are high-pressure machines which can eject clouds of spray or dust reaching the tree tops from the ground, low-volume machines which effectively spray an acre of land with ten gallons of spray fluid or even less, while the coverage from particular ejectors can be calculated with increasing accuracy.

The vast prospects opening out are, indeed, somewhat bewildering, and there is an ever increasing need for accurate guidance to enable the farmer to separate, so to say, the grain from the chaff and to enable him to select those methods which are best suited to his particular crops and conditions.

With all this wealth of new knowledge on the chemical and physical side there may be some danger that alternative methods of pest control may be overlooked. Lord Bledisloe, in his presidential address, wisely laid emphasis on this and pointed out that the use of parasites and predators as controllers of disease were also of great importance, while the plant breeder can render invaluable services by producing crop varieties specially resistant or immune to pests and diseases.

There is need for an overall approach to the problems which, while taking advantage of the resources made available by the chemist, also recognises the role that can be played by alternative methods. In some circumstances the chemical approach may be the best but in others biological methods may offer advantages. The aim must be to secure harmony between them and to ensure that each is employed in the circumstances appropriate to it. The chemist, the physicist and the biologist have shown how well they can collaborate in the field of pesticide application and it should not be impossible to secure similar collaboration in this wider aspect.

Of the success of the present Conference there can be no manner of doubt, but is it too much to hope that in the 3rd Congress, which it has been agreed shall be held in Paris in 1951, a place will also be found for the discussion of biological methods of control to assist that coordination between all the available methods of attacking the problem, which is so obviously desirable?

World Cereals Today

RICE

STAPLE FOOD OF HALF THE WORLD

D. H. GRIST, Dp. Ag. (Cantab)

More than half the population of the world depend on rice for their staple food. Most of the world's rice is grown on small plots by peasants throughout the Eastern tropics. Their methods are primitive and follow traditions thousands of years old. Large areas of these countries were devastated during the war, and although recovery is proceeding, world production is still far below the pre-war figure, notwithstanding that production by modern mechanised methods in the U.S.A. and elsewhere has greatly increased.

Rice eating populations are growing rapidly, and increased rice production is on this account one of the major agricultural problems with which the world is faced. On its solution the future of the world may depend.

The author of this article, in which the rice situation is outlined and discussed, was for many years Agricultural Economist in the Malayan Department of Agriculture, and has wide knowledge of the economics of rice and extensive experience of its production under Eastern conditions.

RICE is unique among cereals in that the bulk of it is produced by methods of cultivation which have remained almost unchanged since before the Christian era. Most of it is produced and consumed in Asiatic countries, indeed, in spite of the war and current hostilities 93% of the world's rice is still grown in Asia. This underlines the enormous importance of rice to the average Asiatic. It means much more to him than does wheat to the European for whereas in the varied diet of the West bread has become almost incidental, in Asia countless millions subsist almost entirely on rice which supplies about 70% of the total calories in their diet.

Methods of production

Before explaining the present world rice situation, a few notes on Asiatic methods of cultivation are necessary. As the crop is grown in water the main areas of production are usually the deltas of great rivers, or near the banks of rivers and in valleys where adequate water supply is assured and some degree of irrigation and water control is possible. Rice is usually considered a tropical crop, but excellent yields are obtained in sub-tropical regions and in certain warm-temperate areas, such as Italy and Spain. The main requirements are adequate water for the development of the crop, a soil sufficiently impervious to retain irrigation water, and abundant sunshine.

The average holding is usually only a few acres, very rarely as much as 100 acres, cultivated by peasant farmers with little or no capital and generally hopelessly indebted until harvest time. Cultivation requires much hand labour and for this reason rice is grown almost exclusively in over-populated regions.

Apart from the fact that rice grows in

Terraced rice fields in Southern China

water and that, usually, it is transplanted, its cultivation and habit of growth are not dissimilar to wheat or other cereal crops. In the United States, where the cultivation of rice has been introduced in comparatively recent times, unhampered by the traditional methods that persist in Asia, the crop is grown on large-scale units using modern implements and methods, very similar to those employed in the cultivation of other cereals.

Conditions in Asia

Such, briefly, is the background of the crop upon which most of Asia is dependent. This dependence on one crop—one main source of livelihood, one staple diet—renders a vast population particularly vulnerable to privation, poverty and stark hunger ; to famine conditions that may be local or widespread, depending on the vagaries of the monsoon which may cause scarcity of rains when the land should be flooded, or ill-timed floods that may ruin a promising crop over considerable areas.

The world war led to some destruction of crops, but more serious because more lasting in its effect, was the failure to maintain irrigation systems and the abandonment of cultivated areas, resulting not only in a reduction of the planted area, but lower yields per unit area which may persist for some years. Probably, but for political unrest, two of the main exporting countries namely, Burma and Indo-China, would by this time have regained their pre-war position, since population pressure and economic dependence on rice would have compelled the re-establishment of the rice lands.

As compared with 1938/39 the area under rice in Asia had decreased in 1946 by nearly 4,250,000 acres to a total of 188,500,000 acres, while production fell by 7,700,000 metric tons to a total of 130,700,000 metric tons.

India/Pakistan and China are by far the largest producers of rice ; they account for 61% of the total production. But so dense is the population of these countries that after feeding them little or no surplus remains for export. Apart from these countries, the chief areas of production are centred on the delta of the Irrawadi in Burma, and in Indo-China, Siam, Indonesia, Japan, the Philippines and Korea. Appreciable areas also exist in several other countries in South-East Asia. During the war years efforts were made in countries not directly affected by the war to bridge the gap by increased production. French West Africa, the United States and Brazil were the chief participants, but important as was their effort and that of other countries outside Asia, it was hardly more than equivalent to the decrease in planted area in Burma alone.

Rice in other countries

Rice is grown in some Southern European countries and also in the U.S.S.R., and although the total area in Europe is not large, it is noteworthy that the highest yields per unit area in the world are obtained in Spain. No information is available concerning the present position of rice-growing in the U.S.S.R.

Rice is also grown in several countries in Africa and in Oceania. It was first grown commercially in Australia a few years ago and has extended appreciably, yields being very satisfactory.

In North, Central and South America, rice cultivation dates back some two or three centuries, but for many years it was grown only on a small scale. More recently, however, the industry has undergone a complete reorganisation by the introduction and development of mechanised cultivation, and there are prospects of further expansion provided that present price levels are maintained.

World production and needs

Recent figures published by the Food and Agriculture Organisation of the United Nations show that the pre-war level of world area under rice was 83,700,000 hectares, while the 1948 area is provisionally estimated at 86,000,000 hectares. Pre-war production of rough rice (paddy) was 147,500,000 metric tons, and the estimated production in 1948 was 144,500,000 metric tons. The drop in production occurs in Asia, and particularly in the countries of political unrest.

It might be thought that this decline is so small as to be unimportant, but this is not so ; even on pre-war supplies Asiatic populations were under-nourished, and these populations have grown and are growing so fast that vastly greater rice production than ever before is necessary if they are not to starve.

The pre-war population in the rice-consuming countries of Asia was more than 1,036,000,000, while the 1947 population is put at 1,150,000,000. F.A.O. comments on the position as follows :—

' But apart from the acute problem resulting from the war, world production of rice has failed for decades to keep pace with the growth of the basically rice-eating population. In the period between the two world wars, for instance, production of rice in South and East Asia increased by less than 10%, whereas the population of this region, according to available evidence, increased by more than 20%. The rate of increase of the basically rice-eating population of the world approximates 10,000,000 each year. In order to feed these additional people, world production of rice needs to be increased annually by at least 1,300,000 metric tons (milled or cleaned basis).'

The export position

Practically all the countries of Asia produce rice but only five are normally in a position to export it, the remainder must buy rice on the world markets to supplement local production. Before the war the main exporting countries were Burma, Siam, Indo-China, Korea and Formosa ;

small amounts were exported from certain other countries such as the United States, Brazil and Egypt, but 94% of exports came from Asiatic countries.

Since the war the position has considerably changed, shipments of rice from exporting countries being 1,900,000 tons in 1946 and 2,200,000 tons in 1947, as compared with 8,300,000 tons per annum before the war. The sources and amounts of the rice exports pre-war and for the year 1947 are shown in the Table below.

Exporter	*Average 1934-38*	*Percentage of total*	1947	*Percentage of total*
		(*In thousands of tons*)		
Burma	3,070	37.1	805	36.0
Siam	1,388	16.8	390	17.4
French Indo-China	1,290	15.6	43	1.9
Korea	1,158	14.0	—	—
Formosa	622	7.5	—	—
Brazil	48	0.6	182	8.1
Egypt	97	1.2	197	8.8
United States	68	0.9	446	19.9
Others	532	6.3	174	7.9
TOTAL	8,283		2,237	

Outlook for 1949

World production of cleaned rice for 1948/9 is estimated at 106,000,000 metric tons, about 6% more than in the preceding year, and there should, therefore, be 3,600,000 metric tons available for export. The increase is said to be due to larger production in Asia, and to unexpected larger stocks carried over from the preceding year. The major part of the increase was in the Asiatic importing countries and reflects official encouragement for increased planting in order to render these regions less dependent on imports.

Siam is expected to be the most important exporter in 1949, the surplus for export being estimated at 1,250,000 metric tons, or about 88% of pre-war exports, as compared with 771,000 metric tons in 1948 and 383,000 metric tons in 1947.

Pre-war exports from Burma were more than one-third of world shipments. Before the political disturbances in that country in 1948 prospects of recovery of the export trade were favourable, and it was expected that nearly 1,500,000 metric tons would be available in 1948. The disturbances, however, have seriously disrupted trade, immobilising stocks up country and in ports. The 1948 exports were 1,216,000 metric tons, or 41% of the pre-war average, while the crop for 1948-49 is expected to be about 15% less than that of the previous year.

Unless the political situation improves in Indo-China this area's exports are also expected to remain unsatisfactory. The 1948 exports are estimated at 181,000 metric tons or only 12% of the pre-war figure.

Elsewhere, production is generally well maintained. Exports from the United States were 11% of the total in 1948, compared with 1% before the war. The planted area has declined slightly so that production in 1949 may be about 2% less than in the previous year. Egyptian crops are high, but local demand has now increased. European crops, on the whole, are satisfactory and exports from Australia are expected to be about 18,000 metric tons of cleaned rice. Exports from North America and Europe in 1949 may slightly exceed 1948 shipments; South American exports, however, will be considerably less than in the previous year.

Allocation of supplies

To ensure that available supplies are fairly allocated the international movement of rice is governed by an allocation system, controlled at first by the Combined Food Board, but since mid-1946 by the International Emergency Food Committee (I.E.F.C.) with a sub-committee on rice, located at Singapore.

The International Rice Commission recommended at the Baguio Rice Conference in 1948, has now been established and it is considering how best to expand rice production, the better utilisation of supplies, nutrition, and the improvement of rice statistics.

F.A.O. report that there has been effective co-operation by importing and exporting countries in implementing the allocations recommended by the Rice Committee.

Immediate problems

The most urgent problem now is to increase supplies available for export to enable rice rationing to be better equated to the needs of rice-eating peoples. The International Rice Conference at Baguio in 1948, concluded that a material improvement would result from active steps to eliminate waste. It was considered that more than 10,000,000 tons of rice are lost annually through insect and rodent infestation, faulty methods of storage, wasteful milling, and by unsatisfactory methods of household preparation. The meeting concluded that 'immediate improvement in the quantities of rice available for human consumption will be achieved if member governments of all rice-producing countries undertake during 1948 a vigorous campaign to conserve rice supplies.'

The conference advocated undermilling and efforts to reduce wasteful mill operation. It is thought that action on these lines has already had some effect and a number of countries have insisted on some degree of undermilling. It has been difficult, however, to insist on improved milling for in many cases the mill machinery is obsolete and cannot conform with the requirements.

Longer range problems

I.E.F.C. is concerned primarily with problems in the rice-growing countries and the repercussions in rice-consuming areas as a result of the war, but even if they are solved there remains the even more serious problem of providing ever-increasing supplies to meet the demands due to increasing population, *i.e.*, to provide for an annual increase in crops of 1,300,000 tons of milled rice. It is evident that this increase is possible in two ways, (*a*) by a steady increase in the total area planted with rice, and/or (*b*) by increased yields per unit area.

(*Courtesy: Rotary Hoes Ltd.*

East meets west. A modern mechanical cultivator in use on rice land in Siam

Harvesting rice by primitive native hand method in Malaya

Potentialities in Asia . . .

Undoubtedly some increase in area is possible and is to be expected in Asia under the present system of cultivation; the main limitations are the provision of suitable and cheaply irrigable land and an adequate population to work it by the present primitive methods. Should, however, the present attempts to mechanise the cultivation of the crop under Asiatic conditions prove successful (and a very searching investigation of this problem is at present being undertaken) there are possibilities of developments in areas at present considered unsuitable for this crop. Even in Burma, Siam and Indo-China there are possibilities of further extensions of the planted area, though such developments would probably require considerable capital outlay, particularly for the provision of adequate irrigation. Extensive areas of land suitable for rice cultivation exist in other countries in Asia, although it is not clear whether they are also suitable for other and possibly competitive forms of cultivation. Hitherto, the general rule seems to have been to consider that other forms of cultivation have priority over rice, but it may well be that with the growing demand for rice, and better prices, governmental policy and economic considerations may lead to a wider conception of the classes of land that should be developed for rice cultivation.

. . . Africa and America

The potentialities for increased production in Africa and the Americas are immense, and given a favourable and fairly steady stable price for the commodity, considerable increases in areas may be expected in the next decade or so. One cannot but be particularly impressed by the possibilities—and the probability—of a considerable extension of the area under rice that is likely to take place in Africa.

Unirrigated rice

Some varieties of rice will grow without irrigation. Hitherto, these 'dry' rices have not been widely cultivated, but selection and hybridisation might conceivably lead to the production of strains or new varieties capable of yielding crops equal to those cultivated under irrigation. Should this line of research prove successful, rice production might be revolutionised by the cultivation of this crop in areas where irrigation is impossible, that is in many tropical and sub-tropical regions.

Improvement in yields

Yields of rice vary greatly in different countries; they may range from more than 27 cwt. per acre in Spain down to less than 4 cwt. per acre in some tropical countries. Even admitting that this great variation is in part due to climatic conditions, there is little doubt that production could be materially raised in the countries of low yield, although the possibilities are necessarily less where production per unit is already high.

In the East

A large proportion of the crop is grown on lands not provided with controlled irrigation and drainage; often the crop depends on rainwater retained on the land by primitive bunds, still more frequently it depends on the seasonal flow of rivers, or the utilisation of limited sources of water by primitive methods. Under such conditions the hazard of weather is always present; too little rain may hinder the establishment of the crop, too much may lead to floods and wash it away. Accordingly improvements in drainage to protect the land and to enable water to be retained or removed in accordance with the requirements of the crop, and adequate supplies of irrigation water are the first steps towards improved yields. The development of improved drainage and irrigation necessitates a capital outlay and technical skill quite beyond the resources of the Asiatic cultivator. It follows, therefore, that the initiative for such improvements lies with the governments concerned.

Second in importance is improvement of the varieties of rice grown. Some progress in this direction has been made, but there is vast scope for further work. In Eastern countries, at any rate, varieties ordinarily grown are genetically very impure and pure line selection has led to the isolation of higher yielding strains in many places. Very little has yet been accomplished in producing new varieties by hybridisation and experience with other cereals encourages the belief that here too there is great scope for development. Of particular importance is the selection of varieties suited to particular environments. Also important is selection for milling qualities and food value. On the latter point little is known but it has been established that different varieties exhibit considerable variation in this respect, but the problem is complicated by the fact that quality may vary with soil and climate.

The use of fertilisers is frequently advocated as a means of increasing yields, but it is still uncertain how far their use is economic. In some cases significant increases have followed their use, but more often results have been inconclusive and sometimes no improvement has been observed. There is need for much research on this point in all rice producing countries, which must include further research into the chemical, physical and biological characters of rice soils.

Cultivation

It is often suggested that yields could be raised if methods of cultivation were improved. The traditional Asiatic methods of cultivation are, it is true, wasteful of labour, but they are usually basically sound in principle, although naturally practice varies and in some places there is scope for

improvement, especially in more remote areas. While, therefore, the use of modern implements and mechanical aids to cultivation may cheapen the cost of production and enable more extensive areas to be cultivated through economy of labour, they are unlikely to produce any marked increase in yield per unit area cultivated.

The systematic continuous cropping of land under rice for very long periods which is traditional in Asia, is thought by some authorities to account for the lower yields obtained in comparison, *e.g.*, with those under more or less similar climatic conditions on the newer lands in South America. This may be the case but it cannot be regarded as fully established since instances are known of lands in the East which have been continuously cultivated in rice for long periods and which give annual crops little inferior to those obtained in Spain or Italy.

Conclusion

To sum up; it may be regarded as established that improvements in yield will follow judicious improvements in drainage and irrigation, and improvements of the varieties of rice cultivated. It is possible that they may also follow the more extended use of manures, modifications in cropping practice and the use of new or improved methods of cultivation but this can be assessed only by further investigation.

Experience in America and elsewhere shows that under western conditions, however, mechanical methods enable greatly increased production with economy of labour by facilitating extension of the area cultivated. It is still uncertain how far such methods can be applied to Eastern conditions, but if experiments in progress give satisfactory results they may greatly assist in solving the problem of increased supplies.

Finally, some reference must be made to the economic conditions of the Asiatic cultivator, without whose active co-operation schemes for increased rice production, no matter how sound they may be, will prove ineffective. To secure success his lot must be made more attractive through improved social services and education, and means must be found to improve his financial stability. There must also be close contact, through the extension of the services of the departments concerned, between him and the technical experts, to ensure that the results of research are applied to his own problems and to the great masses of people to whom rice is, indeed, the staff of life.

Photos on pp. 5 and 8 by courtesy of Dept. Public Relations, Federation of Malaya, and on page 6 by courtesy of the Central Office of Information, London.

Colonial Month in London

COLONIAL MONTH, organised by the Colonial Office with the assistance of the Central Office of Information in London, was designed to present a general picture of the Colonies and to illustrate the relationship between them and Britain. It was inaugurated in a special ceremony by His Majesty the King at Church House, Westminster, on Tuesday, June 21. In his speech His Majesty thanked and praised the Colonial peoples for their loyalty and for their splendid contribution to victory. He alluded to the boundless prospects for development which the colonies presented and acknowledged the devoted labours of many generations of men and women of various races who have worked to weld the framework of the Commonwealth.

The centre piece of Colonial Month was the official exhibition ' Focus on Colonial Progress ', staged by the Central Office of Information on their site at Marble Arch, but a large number of public institutions and private firms joined in the concerted effort to stimulate interest in the colonies. In all, 23 public organisations, including the British Museum, the Victoria and Albert Museum, the Imperial Institute, the Royal Gardens, Kew, the Royal Geographical Society, the Royal Empire Society, the West India Committee and other bodies participated, while among the firms who staged special exhibits were Messrs. Cadburys, Austin Reed and many others.

The Exhibition aroused so much popular interest that the closing date originally fixed for July 30, was subsequently extended until August 31. The intention of the exhibit at Marble Arch was to give a review in miniature of the circumstances and conditions in the different groups of colonies and to show the manner in which they are being affected by the policy of Colonial Development. The space available was limited, and this in itself imposed considerable restrictions, but within these limits a picture of great interest was developed which threw into high relief many of the problems of the Colonial Dependencies and demonstrated the extent to which the world is now dependent upon them for many of the necessities of life.

Perhaps not unnaturally the major emphasis was laid upon progress in the social sphere and the improvements brought about, particularly in hygiene and public health, education and similar social services. The exhibition, however, also dealt with some of the aspects of Colonial agriculture, although some may think that insufficient stress was laid on the fact that ability to raise living standards and to provide social services is dependent on improved and increased agricultural production.

Agricultural exhibits

In connection with agriculture, the exhibit of live locusts attracted a large amount of attention and much interest was aroused in the information provided concerning the organisation of the Locust Control Campaign.

A film purporting to describe and discuss various aspects of colonial agriculture was continuously shown; with such a vast subject it is extremely difficult to say anything really effective in the space of five minutes or so, but it did seem unfortunate that the commentary usually bore little if any relationship to the pictures shown, while the pictures themselves could in many instances hardly be described as typical.

An exhibit which attracted much attention was an ingenious diorama which, by means of a dissolving view effect, demonstrated the damage which could be done by soil erosion. It was, perhaps, a trifle unfortunate that it was not entirely clear whether the erosion was the outcome of the cultural methods exhibited (as it might well be) or whether it was intended to suggest that the cultural methods could effectively repair the damage which had taken place (which, to say the least of it, seems somewhat doubtful).

Minor criticisms apart however, there can be no question that Colonial Month as a whole has succeeded in helping to arouse increased interest in colonial questions and the part which the colonies play in supplying the needs of the world. The apathy and ignorance concerning colonial matters which is, alas, so widespread in Britain, must be dispelled and if the efforts made have done something towards this they are, indeed, well worth while.

Anhydrous Ammonia as a Fertiliser

In the United States anhydrous ammonia is being increasingly used as a fertiliser and bulk handling has made it cheaper to use than sulphate of ammonia.

The American experience has prompted the Australian authorities to inaugurate trials with it and next season extensive experiments will be carried out on the Murrumbidgee Irrigation Area in New South Wales.

The Threatened Future of COCOA

H. A. TEMPANY

Cocoa and chocolate are essential foods for which there is an ever-expanding demand. The cocoa industry, however, is assailed by many threats and dangers, notably by various pests and diseases which, if they are not held in check, can cause widespread destruction of cocoa trees. Moreover, the structure of the industry in many countries makes the application of control measures particularly difficult. In consequence, the outlook is uncertain. In the following article the position is discussed.

THE epidemic of disease which of late years has attacked cocoa trees in West Africa has aroused widespread interest; if it is not successfully checked it is bound to have very serious repercussions, since considerably more than half the total world's supplies of cocoa and chocolate are derived from that part of the world, and the continued spread of the maladies might eventually result in the disappearance of the major part of the cultivation with disastrous results on future cocoa supplies.

It is true that the 1948-49 cocoa crop from West Africa shows a marked and somewhat unexpected increase over the preceding years, the total production from the Gold Coast and Nigeria considerably exceeding 400,000 tons, as compared with less than 300,000 tons in 1947-48 and an annual average of somewhat less than 400,000 tons for the pre-war years 1935-39. It is apparently the result of a combination of favourable weather, the coming into bearing of large newly planted areas, and the bringing back into bearing of old neglected trees as a consequence of high prices. Possibly it is regarded in some quarters as an indication that apprehensions regarding the future were exaggerated, and certainly market prices have fallen considerably of late months, it is, however, doubtful whether there are any real grounds for optimism. Moreover the situation in other parts of the world is by no means free from difficulties. Consequently a review of the present position is of interest.

Production conditions

Of all tropical orchard crops cocoa is probably among the most sensitive to environmental conditions; soil and climatic requirements must be satisfied within a comparatively narrow range if the crop is to thrive; it is intolerant of high soil acidity, cocoa soils must be sufficiently retentive of moisture but have good natural drainage, and they must have a high content of organic matter in the surface layers and must be adequately supplied with phosphate and potash. A high carbon-nitrogen ratio is essential in high yielding fields and there is some evidence of a mycorrhizal association. It is equally susceptible to climatic influences; high atmospheric humidity is essential and great importance appears to attach to the maintenance of an unbroken canopy in cocoa orchards. Rainfall must be adequate, a lower limit of about 50 in. appears to be indicated, and where rainfall is high a freely draining soil is essential. It is also highly susceptible to temperature and to the effect of high and drying winds.

Moreover the crop is particularly prone to suffer from pests and diseases ; when it is introduced to new countries it has, on occasion, been attacked by hitherto unknown maladies which have taken heavy toll. The effects of disease are made much worse if the soil and climatic requirements of the crop are not fully satisfied.

Obviously cocoa is a crop which should be cultivated under conditions where the rather rigid requirements can be satisfied as closely as possible, strict control exercised over cultural operations and the resources of science readily applied in surmounting difficulties and controlling disease.

Origin and development of cocoa

Cocoa is a native of the tropical forests of South and Central America, where its cultivation originated ; it has been introduced into other parts of the world, notably West Africa, the West Indies, the Netherlands Indies and Ceylon. The total annual production is of the order of 700,000 tons of which rather more than half comes from West Africa, while Latin America supplies about one-third. In West Africa development has been spectacular and rapid and has occurred mainly during the past 50 years ; it originated in a chance introduction, and the industry consists almost entirely of peasant-owned smallholdings scattered piecemeal throughout the forest belt in the Gold Coast, Nigeria and the Ivory Coast with smaller areas elsewhere. In the early days although the Governments regarded the industry with a benevolent eye, little active assistance was given to planters and, like Topsy in Uncle Tom's Cabin, the industry 'just growed.' It is, in fact, a typical product of *laisser faire*.

In South and Central America the industry is the result of bringing into cultivation a naturally occurring tree and cultivation is of long standing. It is grown in many countries including Brazil, Venezuela, Ecuador, Colombia, most of the Central American republics and Mexico. There are some large estates but there are also many smallholdings and cultivation is widely scattered. In the British West Indies cultivation is confined mainly to Trinidad and Grenada, both on small estates and smallholdings ; experience has shown that much of the cocoa in Trinidad is planted on soils unsuited to the crop.

In both West Africa and in the Western Hemisphere the industry is threatened with disease, in West Africa with the complex of disease known as Swollen Shoot and also by Capsid bugs, in the Western Hemisphere by Witches Broom disease and Monilia Pod Rot.

(*Crown copyright*

Inspecting cages containing sucking insects (Sahlbergella) which attack cocoa, at the Experiment Station, Tafo, Gold Coast

Taken as a whole the industry presents a contrast to the other two great beverage producing industries, tea and coffee, particularly the former, where much of the cultivation is carried out on plantations of considerable size worked by modern methods, cocoa on the other hand is grown largely on small and scattered holdings worked by peasants with slender resources and low educational standards. Yields are, in any case, low, while the structure of the industry makes it particularly vulnerable to adverse influences ; the task of improvement in these conditions is bound to be particularly difficult and the control of disease peculiarly hard.

The West African position

The difficulties are aptly illustrated by occurrences in connection with cocoa disease in West Africa. As is well known the industry is threatened with extinction by a virus disease known as swollen shoot, so-called because infected trees show characteristic swellings on the shoots and branches ; it is caused by a virus infection transmitted by various species of mealy bug. It is also threatened by capsid bugs which attack branches and twigs and cause their death, they are less dangerous than swollen shoot but serious enough ; there are also a number of other diseases of less importance.

The virus is harboured by a number of forest trees, nine of which have been identified ; it does them no harm but they serve as reservoirs from which cocoa is infected. Some 13 different strains of the virus are now known, some are lethal and kill infected cocoa trees in about 12 months, some are sub-lethal and may take years to kill a tree, while many others are apparently innocuous. Trees infected with the lethal and sub-lethal strains cannot recover and are doomed. The malady spreads slowly at first but as infection extends its advance becomes inexorable and rapid. It was first recognised about 1936 but the cause was not diagnosed till 1939. Today it is estimated to be spreading at the rate of 15,000,000 trees a year and by the end of 1949 46,000,000 trees will have died from it.

No direct remedy exists and experience

with other viruses indicates that it is unlikely that one will be found. However, it has been established that if diseased trees and those in contact with them are cut out so soon as infection shows itself, the spread of the disease can be checked, while if precautions are observed cocoa can be replanted with prospects that it will succeed. A large-scale campaign has been inaugurated by the Government to survey infected areas and to ensuring that cutting out is enforced, with compensation for trees destroyed and grants in aid of replanting, accompanied by propaganda to convince farmers of the dangers and the effectiveness of cutting out as a means of checking the disease.

A good deal of resistance to these measures has, however, been encountered from cocoa farmers ; they are not unnaturally averse to seeing apparently healthy trees removed. Serious trouble broke out and there was an outbreak of rioting in some localities on account of it.

Recently a scientific commission composed of virus experts of international repute visited the Gold Coast to report on the matter. They confirmed the dangers and that cutting out is the only known measure for the control of the disease. They advocated that it should be continued on a greatly increased scale. They also advocated that subsidiary measures should be tried but pointed out that though they might assist control and rehabilitation they remained secondary to cutting out.

Secondary defensive measures

Secondary measures include the possibility of finding resistant types of cocoa, the control of the mealy bug vectors by insecticides, the introduction of parasites and predators on mealy bugs, and the conferring of immunity on healthy trees by inoculating them with non-virulent strains.

So far as concerns other pests it has been found that a fairly effective control of capsid bugs can be effected by spraying with D.D.T. and other insecticides.

The difficulty, however, is to ensure the application of remedial measures over a very large number indeed of small separately owned cocoa farms, scattered about throughout the cocoa belt, often difficult of access and of which no official record previously existed. Such conditions, in fact, are the most difficult it is possible to conceive when it comes to applying remedial measures effectively, and this holds equally true when methods of improving cultivation and increasing yields are concerned.

The position in the W. Hemisphere

In the Western Hemisphere the position, although differing in detail from that in West Africa, presents certain broad parallels. The dominating factor is once again disease, this time in the shape of two fungoid diseases, one Witches Broom due to the fungus *Marasmius perniciosus* and the other to a species of Monilia which attacks the pods. A partial control of Witches Broom can be effected by removal of the witches brooms, which are the fructifications of the fungus, as they appear and by care and attention to the sanitation of cocoa orchards, but this can be ensured only when the most vigilant control is exercised over operations and the properties are well maintained and well managed. As in many cases cultivation conditions do not differ markedly from those obtaining in West Africa, this is difficult. The greatest hope lies in finding varieties immune or resistant to both maladies, and as a result of extensive searches a number of varieties showing resistance have, in fact, been isolated ; but the task of replacing existing stands with resistant types is one of great magnitude which even if it can be accomplished must take many years.

So far virus diseases have not yet been recorded in South and Central America, but in Trinidad it has been found that a virus disease exists resembling the sub-lethal form of swollen shoot. On all these accounts the position in the Western Hemisphere also is very far from reassuring.

Research and the cocoa industry

Until comparatively recently there has been little provision of scientific services to assist cocoa growers. In the early years of the present century some work was done in the British West Indies and in British West Africa by the small scientific staffs of the local Departments of Agriculture, but resources were inadequate to deal effectively with the numerous problems. In the South American regions provision was still more exiguous or non-existent. The decadent condition of the West Indian industry and particularly the appearance of Witches Broom disease in Trinidad, led to the inauguration of a Cocoa Research

(Courtesy : Cadbury Bros. Ltd.

Results of swollen shoot disease—a dead cocoa tree on a farm in the Gold Coast

Scheme as an adjunct of the Imperial College of Tropical Agriculture in 1929. This, small though it was, drew attention to many defects of the industry ; it showed incidentally that cocoa, being heterozygous, the yields of individual trees varied enormously, and that by planting material derived from high-yielding trees and propagated vegetatively, yields of cocoa per acre could be trebled or quadrupled.

Searches for varieties resistant to Witches Broom disease were inaugurated in collaboration with the Trinidad Government, through the South American region by the late Dr. F. J. Pound, work was done on cocoa soils and some attention given to factors influencing quality.

In West Africa a cocoa research laboratory was erected at Tafo in the Gold Coast about 1937 and staffed by five scientific officers who, in addition to cocoa problems, had to deal with all problems connected with other agricultural industries in the territory. The outbreak of swollen shoot showed the inadequacy of the provision and in 1944, despite the existence of war conditions, a staff of 15 scientists was assembled to deal with the matter and this subsequently developed into the West African Cocoa Research Institute.

Simultaneously the Secretary of State for the Colonies (at that time Mr. Oliver Stanley) set up a consultative research committee in the United Kingdom comprising a number of leading scientists, to advise on research matters and in 1945 a cocoa research conference was held at the Colonial Office which put forward long term plans and programmes of work for establishing cocoa research on an adequate basis in British West Africa and the British West Indies. These have since been accepted as the basis for future work and ample financial provision made to implement them.

Of recent years British cocoa manufacturers have taken a very active interest in the matter and since 1946 they have assisted in various ways to sponsor a series of annual conferences on an international basis at which the problems of the industry are reviewed.

In 1947 the cocoa trade in the U.S.A., working in association with the Pan-American Union and the United States Department of Agriculture sponsored the formation of an American Cocoa Research Institute for Latin America and established a Cocoa Centre at Turrialba in Costa Rica.

It can therefore be said that the cocoa industry is now well provided with facilities for research and much is being done to find the solutions of the many problems with which the industry is confronted.

(Courtesy : Cadbury Bros. Ltd.

Semi-wild cocoa tree in British Honduras

Problems requiring solution

Disease control is, naturally, the principal problem and upon this efforts are being mainly concentrated, particularly in West Africa, but many others have to be faced. They include problems of cultivation and manuring, the production and propagation of new and higher yielding varieties, physiological problems of growth, questions relating to eco-climatic conditions ; questions relating to quality are also important, involving as they do both the type and variety of cocoa cultivated as well as the methods used in the preparation of the product, while the economics of the industry and the marketing of cocoa all have a bearing and require systematic study.

Relatively little information is as yet available on many of these matters but in due course it is bound to increase ; the main difficulty lies in getting the results applied in practice especially where, as in West Africa, the cultivation is made up of very large numbers of small holdings.

Possibilities of production elsewhere

The difficulties in regard to disease have turned attention to possibilities of cocoa growing in regions other than Africa and South America. The exacting nature of the crop limits the range of suitable places. The recent visit of Dr. Cheesman to Malaya and Borneo shows that probably about 300,000 acres of suitable land exist in this region ; suitable areas also doubtless exist in East Africa, although the sum total is probably not very extensive ; there are undoubted possibilites on a limited scale in Zanzibar which are being explored, while there are some possibilities in parts of the South Pacific region, but here labour shortage is a difficulty. The greatest possibilities undoubtedly are in the vast Amazon basin in South America, while there are still considerable undeveloped suitable areas in West Africa. Developments primarily depend on ability to control cocoa diseases, but in South America a dominating factor will also be the availability of labour.

The outlook

Undoubtedly the disease position is threatening but there is little doubt that both in the West African and the American region it can be surmounted provided it is possible to enforce the necessary measures with the required degree of efficiency, and here the existing structure of the industry is the difficulty. It is essential that the crop should be grown under conditions which enable operations to be conducted with maximum efficiency.

Sir Geoffrey Evans, speaking at the International Conference held under the auspices of the Cocoa, Chocolate and Confectionery Alliance in September 1948 said : ' One thing I am perfectly clear about and it is that if cocoa is to prove remunerative it will need to be properly cultivated and the best scientific advice will be necessary. If it is to be grown merely as a forest crop by extensive methods, as has too often been the case in the past, it will fail. In the future the best available planting material must be used and intelligent methods adopted to prevent

the introduction and spread of disease. . . . The indiscriminate production of cocoa on small peasant holdings . . . will never get the necessary yields per acre, the quality, or the control of disease necessary for success.' Although these remarks were made specifically in relation to projected developments in British Guiana and British Honduras, they have a general application.

Future Developments

Either new developments must take the form of large plantations or if they are on smallholdings they must be grouped and made subject to conditions which will enable over all control to be exercised over their entirety. That this can be done is shown e.g. by experience in the Sudan in relation to a totally different crop, namely, cotton.

Actually signs are not wanting that this requirement is becoming appreciated, thus the American Stettinius Corporation in co-operation with the Liberian Government have established large plantations on these lines in Liberia which are expected to yield 50,000 tons annually, and in Mexico the development of large-scale cocoa enterprise is now in progress. So far as concerns existing plantations in West Africa it seems inescapable that if the industry had been organised from the start on some such pattern instead of being allowed to assume the present unordered form, control of the present outbreak of disease would be much easier and the chances of survival of the industry very much greater, while control could be obtained for a very much less cost.

Obviously it is impossible to change the existing pattern overnight but political and economic considerations demand that every effort must be continued to save the industry on its present form and to maintain production. On the other hand it seems clear that being given the nature of the crop and the natural hazards to which it is exposed, the existing pattern of production in unmodified form can never produce a situation that is fully stable.

The task which faces the Governments in West Africa is therefore to find some means whereby the structure of the industry can be altered so as to provide the necessary security while at the same time the existing social order on which the industry is based is not too severely disrupted. It may involve the assumption of a greater degree of control over the operations of the cultivator than has hitherto been thought permissible or politic, but unless this is achieved it is hard to see how the industry can in the long run hope to survive.

Economic factors

Efforts to improve cultural conditions and to safeguard the industry from the many adverse natural agencies with which it is liable to be assailed, must fail, however, if they are not accompanied by stable and economic prices for the product, since too low a price precludes automatically the efficient performance of cultural and protective measures no matter how essential they may be for future security.

Actually in the past one of the chief difficulties of the cocoa industry has been wildly fluctuating world prices. During the last 20 years the world price for cocoa has ranged between £20 and £200 per ton.

The system of centralised marketing and price control introduced during the war by the British Government and recently given greater permanence by the setting up of the Gold Coast and Nigerian Cocoa Marketing Boards represent a notable attempt to surmount these difficulties and to provide necessary safeguards, particularly through the establishment of a price stabilisation fund and the provision of funds for research and disease control. Already it has given evidence of its power to cushion the effects on the producer of the sharp fall in prices which recently occurred. The scheme has not escaped severe criticism in some quarters, but if it can be combined with the necessary degree of increased control over the operations of the cultivator it seems to offer promise of the greater stability which the industry needs if it is to survive.

It is hoped to discuss in more detail the economic aspects of the question in a subsequent article.

Virus Disease of Cocoa in West Africa

THE Annual Report of the West African Cacao Research Institute* contains an account of recent work on the interrelationship of the numerous strains of virus associated with Swollen Shoot disease. Some fifteen or more distinct strains have now been isolated, and designated as strains A to O. Strain A is the lethal form responsible for the greater part of the damage and it has been established that within this strain itself there is marked variability. In outbreaks some trees are infected with milder substrains than the majority and it now appears that Virus A is really a complex of strains of graded virulence.

Immunity to disease

So far no varieties of cocoa have been found which are completely immune to the disease; some clones may however be naturally comparatively tolerant, although this is rare and there is no instance of this being characteristic of an entire clone. On the other hand some clones have the ability to develop within their tissues reactions which change actively virulent Strain A into an attenuated mild form. It has also been found that resistance can be induced in any cocoa plant by artificially injecting it with an attenuated strain.

It has been shown that the numerous strains of virus identified can be divided into four classes, viz. :—

(*a*) those which on injection afford complete protection against Virus A; (*b*) those which afford incomplete protection; (*c*) those which afford no protection; and (*d*) those which afford no protection and which form a symptom complex with Virus A.

So far three strains have been included in class (*a*) one in class (*b*), nine in class (*c*) and one in class (*d*).

Five species of mealybug have now been identified as vectors of different strains of the virus, two new vectors having been discovered last year, namely *Pseudcoccus bukobensis*, Laing and *Ps. longispinus*. *Pseudococcus njalensis* is, however, mainly responsible for infection with Strain A of the virus.

* Annual Report of the West African Cacao Research Institute for the period April 1947 to March 1948. 1949.

World Groundnut Production

A statement in the U.S.D.A. publication *Foreign Crops and Markets* summarises the world production of groundnuts in 1948, which is estimated at a record figure of 11,065,000 short tons of unshelled nuts, representing an increase of 3% over the 1947 crop and 16% over the pre-war average. China, the United States and Nigeria showed significant increases over the previous year, but India's crop was 10% smaller.

Should the various projects for large-scale mechanised production in Africa make substantial progress, world groundnut production may attain a new record in 1949, although present prospects in some other important producing areas indicate a somewhat reduced output.

OIL PALMS

The crop which can do most to increase world vegetable oil supplies

Groundnuts yield edible oils from the first year of their cultivation. Oil palms take about four years to come into bearing. For officially sponsored projects for increasing oil supplies, such as the British East African scheme, which depend for their success upon quick results, the groundnut is thus an attractive choice. But quick results are not necessarily best results, and the fact is that once it is established the palm easily outstrips the groundnut as a producer of oil. Therefore, as argued in this article, extension of the oil palm acreage is all-important if world vegetable oil supplies are to be permanently increased.

(*Courtesy : Sofidoc*

Palm oil storage tanks at Alberta, Belgian Congo

BOTH palm oil and palm kernels are products of the West African oil palm, a crop which gives greater yields of oil per acre than any other. In Malaya and Sumatra plantations established in selected high-yielding Deli seed give yields which commonly exceed one ton of palm oil per acre, while from particularly good areas as much as two tons per acre have been recorded.

When these yields are contrasted with those given by annual oilseed crops the difference is startling. Groundnuts, for example, at an estimated yield of 900 lb. shelled nuts per acre give only 450 lb. of oil per acre. The great attractiveness of the groundnut, however, is that it gives a crop within a few months. Oil palms, on the other hand, take about four years before they come into bearing and do not reach full bearing until seven or eight years after planting. But while it is necessary to achieve a rapid increase in world vegetable oil supplies, it must not be forgotten that steadily rising populations make it imperative to achieve eventually a permanent increase. For this admittedly long-term but nonetheless essential purpose, the palm is unparalleled. For example, over a 15-year period from the date of planting, one acre of oil palms may be expected to produce at least 18,000 lb. of oil apart from further quantities derived from palm kernels. In the same period groundnuts will have yielded only 7,000 lb. of oil.

Habitat of the palm

The palm is a native of tropical Africa and occurs wild throughout the forest belts. Its principal habitat is, however, in the forest regions of West Africa and the Belgian Congo. There are many varieties usually subdivided into those with thick and those with thin shelled kernels.

Until the second decade of the 20th century practically the whole of the supplies came from wild palm in the West African region, the fruit from which was collected by natives and the oil extracted by crude methods. Plantation developments date from the second decade of the 20th century. They have occurred in the Netherlands East Indies and Malaya and also somewhat later in Indo-China and the Far East. There has also been remarkable expansion of plantation production in the Belgian Congo under the Compagnie Huilieres du Congo Belge and also on a

much more limited extent in Nigeria. The plantation development is a striking example of the rapid manner in which production can be expanded being given abundant capital and skilled scientific guidance and direction.

Cultivation

Oil palms require a moderately high rainfall, at least 50 in. per year is necessary and their cultivation, therefore, is confined to the wet tropics. However in many countries there are large undeveloped areas which are potential sources of production. The cost of establishing plantations is high, under pre-war conditions in Malaya it was estimated to be £40 per acre overall to the time production commenced. Today, owing to increased costs it is bound to be much higher, although it seems likely that it can be lowered by the wider use of mechanical aids to planting.

Once the plantation is established, upkeep costs are relatively low, experience favours the use of cover crops and this reduces weeding costs. Once palms are in bearing manuring is essential, the chief requirement being phosphates. The main demands for labour are for harvesting and processing, but as the crop is harvested throughout the year they do not greatly fluctuate, a consideration of great importance in these days of increasing shortages of agricultural labour.

(*Courtesy : Fenn Jacobs and Lever Bros. and Unilever Ltd.*

Palm fruit. A collection point on an estate in Nigeria

Production

It is of some interest to review briefly the present production position in regard to these products. Prior to the war the production of palm oil was about equally divided between West Africa and the Belgian Congo, and Sumatra and Malaya in the Far East, the total average being 537,000 tons annually. Palm kernels came mainly from the African region, the average production being approximately 771,000 tons. In Sumatra and Malaya production had steadily extended since about 1917 exclusively on plantation lines. Parallel but somewhat later extensions occurred on similar lines in the Belgian Congo through the work of the Compagnie Huileries du Congo Belge. West African production, however, lies largely with native African cultivators, although three estates operated by the United Africa Co. did exist.

Supplies from the Far East ceased completely during the Japanese occupation of Malaya and Sumatra, but have since the war been resumed. Figures given in the U.S. Department of Agriculture publication, *Foreign Crops*, for April 1949 show that the total estimated exports of palm oil from all producing countries for the year 1948 amounted to 428,600 tons as compared with 308,000 tons for 1947, and 241,600 tons for 1946. There has thus been a steady increase but the production still falls a long way short of the pre-war average of 537,000 tons. As compared with before the war, production has expanded considerably in Nigeria and the Belgian Congo, the former by 30,000 and the latter by 49,000 tons.

In the Far East there has been marked recovery in Malaya where exports amounted to 51,000 tons in 1947 and 54,000 tons in 1948 as against a pre-war average of 51,000 tons. In Indonesia recovery has been much less pronounced ; even though exports in 1948 jumped to 41,000 tons from the previous year's 1,720 tons, this was less than one-fifth of the pre-war figure of 212,000 tons.

Intensive efforts are being made to rehabilitate plantations in the unoccupied parts of Indonesia and it is hoped that production for the current year may be somewhere between 110,000 and 150,000 tons. If this materialises and if it is accompanied by further expansion in the Belgian Congo and Nigeria, this year's total production of palm oil may well exceed the pre-war figure.

Palm kernel production has also markedly increased of late years, the figures for the last three years being as follows :—

1946 ..	..	537,500 tons
1947 ..	..	617,300 ,,
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It is still, however, well below the pre-war average of 771,000 tons.

There is a large domestic consumption of palm oil in West Africa and on this account the figures given in respect of West Africa represent exports only. The whole production of palm kernels is however exported and this in part accounts for the higher proportion which palm kernels bear to total exports of palm oil and palm kernels as compared with the Far East. Moreover the Delhi variety of oil palm which is practically exclusively grown in the Far East has a lower proportion of kernel to fruit than the majority of African types, and this is an additional reason for the small production of palm kernels.

Manuring

Once palms are in bearing manuring is, of course, essential. If this is neglected yields rapidly deteriorate. Experimental work in Malaya, the Netherlands East Indies and later in the Belgian Congo and Nigeria have shown that the dominant fertilising element is phosphoric acid. Nitrogen may also be needed on occasions, but somewhat contrary to expectation potash manures have, so far, produced little response. Soil character, of course, to an extent dictates the manurial applications at particular points. The plant does best on acid soils, a pH of 4.0—5.0 being indicated as the optimum. The Benin sands of Nigeria of which the pH is about 3.0 to 4.0 are one of the natural habitats of oil palm.

Pests and diseases

The palm is, of course, not without its enemies. In Malaya and Sumatra a bunch rot due to *Marismus palmivora* is a source of difficulty. More serious has been a form of stem rot, while a nettle caterpillar has also given trouble. In the Belgian Congo trouble has also been experienced from a disease recently investigated by Professor C. W. Wardlaw.

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The Western Hemisphere

Until comparatively recently there have been few attempts to introduce the palm into the Western Hemisphere, although there are a number of countries which appear to be well adapted to it. Recently, however, there have been some developments, and plantations of varying size have been established in Costa Rica, Honduras, Guatemala, Brazil, Venezuela and Peru, although it appears that many of the introduced varieties are inferior in yield to the best selected varieties in cultivation in the Far East and the Belgian Congo.

The United Fruit Company has initiated a planting programme on 2,700 hectares of banana land which has been devastated with Panama and Sigatoka disease on the Pacific Coast of Costa Rica. Large possibilities are available in the Amazon basin and in some of the other large river valleys of S. America and no doubt many other smaller areas would be revealed by adequate surveys.

It is, of course, obvious that large-scale plantation development requires the investment of considerable capital in land, buildings and machinery. It also entails the provision of transport facilities and the developments which have occurred in the Far East and the Belgian Congo have only been possible as a result of the provision of facilities for transport in the shape of roads and railways and river transport. It remains to be seen whether the industry is capable of expansion by means of small holdings, but the indications are that if this method of development is chosen means must be found of enabling the holdings to be worked with a considerable measure of centralised control so as to secure some of the advantages which attach to a large estate.

Conclusion

While the shortage of vegetable oils continues it seems clear that taking the long view permanent crops such as oil palm hold out the best prospects for making really substantial additions to world supplies of vegetable oils, since an increase of 500,000 acres in the area planted might be expected to raise the annual outturn of oils and fats by approximately 500,000 tons per annum in seven years' time.

Australian Vegetable Oils

AUSTRALIAN farmlands seem destined to produce an increasing variety and quantity of vegetable oils. One reason for this is that the Australian environment affords a wide variety of soil and climatic combinations, from the tropical to the relatively cold, and from rich volcanic soils and river silts to desert sands and extensive limestone areas. Somewhere in the continent it should be possible to find favourable conditions for growing almost anything.

Development of new crops is, therefore, largely a matter of incentive and the necessary research and experiment in the preliminary stages. So far as oil crops are concerned, the incentive has been provided by world shortages of most vegetable oils. This general opportunity has been reduced to an attractive commercial proposition by manufacturers who have offered a guaranteed price for seed or oil to encourage and assist growers to pioneer the cultivation of such oil crops as linseed and soya beans.

Linseed growing in several of the Australian states can now be regarded as having emerged from the experimental phase, and to be established as a commercial crop.

Cultivation of soya beans has not been so satisfactory. Although the total acreage under soya has increased a good deal more experimental work will be necessary before the crop assumes economic importance.

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Extensive trials are also in progress in several States with other oil crops, especially safflower, rape and sunflowers. These have still to prove their value as commercial crops. On the other hand, peanuts or groundnuts are well established in Queensland, and the acreage is being increased both in Queensland and northern parts of New South Wales.

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TOBACCO

Half Britain's needs could be grown within the Empire

Increasing difficulties in the tobacco supply position as the result of shortage of dollar exchange, gives particular interest to a report recently published by the Stationery Office, on the prospects of increased tobacco production in East and Central Africa. The report is by Mr. S. S. Murray, M.B.E., Commissioner for Nyasaland in the United Kingdom; he served for twenty years as a member of the Government Service of that territory, and during the war was employed by the Colonial Office to advise on matters regarding tobacco. The report is based on information collected during an extensive tour of the Central and East African Dependencies in 1947 and 1948 and deals exhaustively with the whole subject. It is summarised in the following article.*

NICOTIANA tabacum, the species generally cultivated today, probably originated in Brazil ; its cultivation for export began in the 16th century and spread with amazing rapidity. It was the first staple product to be exported from any British Colony, and but for it the whole history of the United States might have taken a different course. In the early years tobacco growing in the then American Colonies was sedulously fostered and protected by Britain ; tobacco growing in England, which during the 17th century attained not inconsiderable proportions, was repressed and by A.D. 1700 had practically died out.

When the United States of America became a separate self-governing nation, tobacco-growing was so firmly entrenched that it was well over a hundred years before any other part of the British Empire sent tobacco to England in large quantities, and it was not until the beginning of the present century that rivals to America's international trade in tobacco began to arise.

These historical considerations have, no doubt, caused the U.S.A. to regard the export trade in tobacco, especially that to the U.K., as her special prerogative. In view, however, of the manner in which the industry was fostered by Great Britain in America's colonial days, it is hardly surprising that existing members of the Commonwealth should resent the efforts of the U.S.A. to prevent the mother country assisting their own developing tobacco industries. There is, in fact, an ever-present fear that this may succeed, and it undoubtedly affects the possibility of rapid expansion of tobacco-growing in Africa.

Types of tobacco

There is no limit to the number of types of tobacco that come into existence ; a type is the product of the combination of a number of factors including the soil on which the crop is grown, the climate, the seed, the methods of cultivation and the curing processes employed. Possibly, soil is the most important, for there is no other crop which is as sensitive as tobacco to small variations in soil. There are three main classes of tobacco, fire-cured, flue-cured and air-cured. Fire-cured tobacco is dark in colour and has large heavy leaves. Flue-cured tobacco is thinner and much more brightly coloured, while air-cured tobacco produces thin, papery leaves. Flue-cured tobacco came into existence as the result of cigarette smoking and is so called because it is cured in barns heated by large flues. Fire-cured tobacco is cured by being hung in barns and exposed to the heat and smoke of open fires. In air-curing the leaves are hung in barns and allowed to cure naturally in the air. Generally speaking, flue-cured tobacco needs soil of a light texture, while heavier soils produce tobacco more suitable for fire-curing and of a heavier type.

Tobacco requires careful cultivation. Young plants must be raised from seed in seed beds, and later transplanted to the field. They usually require fertilisers ; the manures applied will vary with the soil and conditions. Before harvesting, plants require to be topped, while all small and damaged leaves are primed from the base of the plant.

Tobacco may be marketed by private sale or co-operatively, but the usual basis is by auction. About 90% of the tobacco in the U.S.A. is disposed of in this way.

Demand for tobacco

One of the main factors affecting trade is changing consumer habits. Some idea

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of the rapidity with which these can alter is shown by the fact that between 1923 and 1939 the proportion of flue-cured to total exports from the U.S.A. increased from 48.5 to 81.0%. In the same period exports of fire-cured tobacco declined to 16% of their former value. An anomaly of late years is the increasing demand in Europe for American blended cigarettes.

As a rule manufacturers are reluctant to change their blends and the factors which chiefly influence choice are competitive quality and price. The manufacturer alone knows the purpose for which he needs tobacco of a particular type ; the producer is not always able to judge suitability, for often leaf of excellent appearance develops defects of body or texture in curing and processing.

There has been an enormous increase in cigarette smoking in recent years. The major factor in this has been the growth of the habit among women ; moreover, the smoking habit is spreading to new parts of the world, such as Africa and India, where the inhabitants are taking more and more to cigarettes.

As against this, the present high cost of smoking caused by the excessively high taxation in the United Kingdom and elsewhere is deterring many adolescents from contracting the practice.

Marketing conditions are at present abnormal but, eventually, production must reach a stage when supply equals or exceeds demand. Measures such as taxation, controlled imports, and rationed withdrawals from bond may suffice to keep consumption within limits desired by various Governments, but some form of production control also seems essential ; the foundation of such control must be the registration of growers, and this is rapidly becoming a fact with producers in most tobacco-growing countries.

Production in Central Africa

In Central Africa tobacco is produced in Southern Rhodesia, Northern Rhodesia and Nyasaland. In the two former it is grown exclusively as a European crop, but in Nyasaland flue-cured tobacco is grown on European estates and fire- or air-cured almost entirely by natives.

Tobacco-growing started in Nyasaland towards the end of the 19th century and, after some early fluctuations, extended rapidly ; by 1912 exports had reached 4 million lb. annually. In Southern and Northern Rhodesia the industry did not commence until 1911-12 ; in the early days markets chiefly lay in South Africa but, as tobacco production in the Union expanded, this market became more and more restricted. With the introduction of Imperial Preference the English market for tobacco from all three countries expanded and it is now the chief outlet. During and since the recent war production has increased very considerably. The following table abridged from the report shows the total production for the three countries for the years 1943 to 1948 :

(Courtesy : Rhodesia House

Tobacco seedlings protected from the heat by thatch on a tobacco farm in Southern Rhodesia

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Weeding tobacco seedlings before transplantation in Southern Rhodesia

Production in 000s of lb.

Year	*Southern Rhodesia*	*Nyasaland*	*Northern Rhodesia**
1943 ..	27,284	26,769	1,953
1944 ..	25,908	22,217	2,465
1945 ..	40,166	20,582	2,687
1946 ..	41,634	16,770	3,832
1947 ..	46,655	25,966	3,334
1948 ..	64,041	—	—

* Exports

much more limited extent in Nigeria. The plantation development is a striking example of the rapid manner in which production can be expanded being given abundant capital and skilled scientific guidance and direction.

Cultivation

Oil palms require a moderately high rainfall, at least 50 in. per year is necessary and their cultivation, therefore, is confined to the wet tropics. However in many countries there are large undeveloped areas which are potential sources of production. The cost of establishing plantations is high, under pre-war conditions in Malaya it was estimated to be £40 per acre overall to the time production commenced. Today, owing to increased costs it is bound to be much higher, although it seems likely that it can be lowered by the wider use of mechanical aids to planting.

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It is of some interest to review briefly the present production position in regard to these products. Prior to the war the production of palm oil was about equally divided between West Africa and the Belgian Congo, and Sumatra and Malaya in the Far East, the total average being 537,000 tons annually. Palm kernels came mainly from the African region, the average production being approximately 771,000 tons. In Sumatra and Malaya production had steadily extended since about 1917 exclusively on plantation lines. Parallel but somewhat later extensions occurred on similar lines in the Belgian Congo through the work of the Compagnie Huileries du Congo Belge. West African production, however, lies largely with native African cultivators, although three estates operated by the United Africa Co. did exist.

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Year	*Southern Rhodesia*	*Nyasaland*	*Northern Rhodesia**
1943	27,284	26,769	1,953
1944	25,008	22,217	2,465
1945	40,166	20,582	2,687
1946	41,634	16,770	3,832
1947	46,655	25,966	3,334
1948	64,041	—	—

* Exports

Southern and Northern Rhodesia mainly produce flue-cured tobacco, but in Southern Rhodesia Turkish type tobacco is also widely cultivated and there is, in addition, appreciable production of fire-cured tobacco. In Northern Rhodesia the production of Turkish is also increasing and there is a small but growing production of air-cured White Burley tobacco by natives.

In Nyasaland dark fire-cured tobacco grown by natives accounts for about 75% of the production and the remainder is made up of flue-cured produced on European plantations and air-cured mainly grown by native tenants on European-owned estates.

Marketing

Marketing by auction is now compulsory in all three territories, except that in North-Western Rhodesia most of the tobacco is marketed through the Northern Rhodesia Tobacco Co-operative Society. The auction system was introduced in Southern Rhodesia in 1936, in Nyasaland in 1938, and in Northern Rhodesia in 1939.

Before its introduction there was not much market for tobacco from these countries outside the United Kingdom and South Africa but, since then, trade with other countries has expanded considerably. By 1946, countries taking Southern Rhodesian tobacco had increased from three before the war to thirteen, while Nyasaland, which in 1937 exported only to four countries outside the United Kingdom, in 1947 was exporting to 29 separate countries. A particularly valuable trade has arisen with West Africa, for which market a specially-prepared type is made which is used in trade and barter before it is finally consumed.

Latterly the U.K. market for Southern Rhodesian tobacco showed signs of falling off and this led, in 1947, to an arrangement between the Southern Rhodesian Tobacco Marketing Board and the British Board of Trade whereby British manufacturers agreed to purchase at the auctions each year for the five years commencing with 1948, two-thirds of the Rhodesian flue-cured crop up to a total of 46 million pounds in any one year.

Apart from export trade there is a considerable and growing market for the produce of the industry locally, particularly in Southern Rhodesia.

Prospects

In Southern Rhodesia rising costs of production, due primarily to the great increase in wages and also to the need for and high cost of fertilisers, is a dominant consideration. There has been also a back log arising from inability to obtain machinery and equipment during the war. A great deal of capital is now being sunk in mechanising the industry. Costs of production are stated to be about 1s. 3d. per pound of tobacco.

(*Courtesy : Rhodesia House*

Tobacco ready for harvesting in Southern Rhodesia

In Nyasaland, in the European areas in the Shire Highlands, there is no likelihood of big increases in production as the soils are becoming worn out and yields are persistently low. There are some possibilities of expansion however, in other localities.

Production by native growers is a big problem and is mainly one of restriction and control of production to ensure improvement of quality ; especially in regard to fire-cured tobacco which is a product steadily going out of fashion in favour of flue-cured types.

To safeguard progress, provision for research is obviously essential. It is understood that in Southern Rhodesia extensive provision in this regard is being made, while in Nyasaland the establishment of a research station at Lilongwe is in progress.

Provided the various difficulties can be overcome Mr. Murray expresses the opinion that a total annual production of 180 million lb. of tobacco from the Central African region would not be unduly visionary.

Production in East Africa

The East African Group of Dependencies consists of Kenya, Tanganyika and Uganda, which form one Customs Union. They have a total area of 679,000 square miles and a total population of 13,514,000.

Kenya

In Kenya there has never been much development of tobacco cultivation. Various efforts have been made by the Kenya Agricultural Department in association with the British-American Tobacco Company to establish an industry but with only limited success. Results have been successful as experiments, but have led to no widespread production. The lines on which developments were attempted were production of flue-cured tobacco by natives, the green leaf being bought from the growers and centrally cured by the Company. A little tobacco is also grown by Europeans in Trans Nzoia.

One of the difficulties is that experience has shown that owing to the risk of mildew, tobacco cannot succeed at altitudes over 4,100 feet, and as much of the country is above this elevation, this limits possibilities.

Uganda

In Uganda tobacco is fairly extensively cultivated, particularly in the Western Province and there has been a native fire-cured tobacco industry for the past twenty years. In 1943 production in the district of Bunyoro reached nearly 4 million lb., but is now only half that figure. The

industry has fluctuated mainly by reason of varying prices and the counter-attractions of competing industries, particularly cotton, prices are controlled by the Government.

There has been some export trade in dark fired tobacco, but of late years it has languished mainly because prices paid to growers have not been much more than half those which have been received for a similar product by native growers in Nyasaland.

The need to expand the production of dark fired tobacco is urgent to meet demands of local factories as well as for the export trade to other East African Dependencies as well as to the Belgian Congo and other parts of Africa, and

(Courtesy : U.S. Information Service

A device for planting out tobacco seedlings used in U.S.A. It is here seen in operation on a tobacco farm in the Southern States

efforts are being made to expand in other parts of Uganda.

There is also an industry of some little importance in air-cured tobacco in the West Nile Province, while some flue-cured tobacco is produced on a European estate in the same region.

Well-equipped factories for the manufacture of tobacco exist at Kampala and Jinja, and at the latter place a new factory owned by the British-American Tobacco Company is in course of erection, which, when complete, will be one of the most up-to-date in the world.

There is an important export trade in cigarettes.

There is also an industry of some little importance in the cultivation of *Nicotiana rustica* for making nicotine extract used as an insecticide.

Tanganyika

There appear to be great possibilities of expansion of tobacco growing in Tanganyika. There is already considerable production of both fire-cured tobacco by natives and flue-cured tobacco by Europeans on estates, and there is an appreciable export trade.

Total production is apparently of the order of 3 million lb. annually, exports for the three years 1944-46 have been as follows :—

1944	2,339,000 lb.
1945	2,094,000 ,,
1946	2,069,000 ,,

The majority of the exports go to Uganda and Kenya where they are manufactured, but there is also appreciable export to the United Kindgom and some other countries.

Native tobacco is marketed through a union of native co-operatives, while a non-native Tobacco Board has been created to control this side of the industry.

There are undoubtedly large areas where the soil and the climate lend themselves to tobacco production, and the prospects for large-scale development depend largely on the attitude of the manufacturers and the Government of the United Kingdom.

The outlook for East Africa

Mr. Murray concludes that the immediate aim of the East African Group should be to make up the present shortage of leaf and to replace imports by locally produced tobacco. In the near future this would require an additional production of 5 or 6 million lb. of leaf ; when this has been done expansion of the export trade could be envisaged and a good foundation will have been laid on which to build up an export trade.

Moreover, as development takes place and more natives are employed at high wages and European populations increase local consumption of better grade cigarettes may be expected to increase at an ever increasing rate.

Rapid expansion for export, if the demand arose, could be achieved, but it would involve a good deal of outside help for although tobacco can be grown easily enough, the preparation and marketing of large additional quantities is a far more difficult matter.

General conclusions

It is obvious from the report that the possibilities for increased production of tobacco in these regions is very great. Today tobacco production is the major industry in the Rhodesias and Nyasaland, while in East Africa it is already firmly established and the possibilities of expansion are very great. The report says nothing concerning possibilities in other parts of Africa, but they are not inconsiderable ; for example, in parts of Nigeria and the Gold Coast conditions favourable to tobacco production exist. In Canada, India, New Zealand and Australia increasing quantities of tobacco are now being grown for home consumption and export, and the supremacy of the U.S.A. is being definitely challenged.

At present the amount of Empire tobacco used in cigarettes consumed in this country is probably about 11%. In 1938 it was 6%, and Mr. Murray considers that it would not be unduly optimistic to envisage a time when half the tobacco consumed in this country is grown within the Empire.

(Courtesy : U.S. Information Service

Tobacco leaf being hung up for air curing in a barn on a plantation in one of the Southern States of the U.S.A.

CROP PROTECTION CONGRESS

THE International Congress of Crop Protection was held in London between July 20 and July 30 ; it was the second of its kind, the first having been held at Louvain in Belgium in 1946.

Held under the presidency of the Rt. Hon. Viscount Bledisloe, the Conference was attended by 600 delegates from 30 different countries, the meetings for the most part taking place in the Imperial College of Science and Technology, South Kensington.

The organisation was undertaken by an executive committee under the chairmanship of Dr. L. H. Lampitt, and subcommittees dealt with various special aspects of the work. The excellence of the arrangements enabled the work to be carried out with the maximum of efficiency.

The Congress was organised in six sections each with its own President of Honour and Chairman, the subjects dealt with by each being as follows :

Section	*President of Honour*	*Chairman*
I Insecticides	Prof. Sir Ian Heilbron, D.S.O., F.R.S.	C. T. Gimmingham, O.B.E.
II Fungicides	Prof. H. Osvald (Sweden)	Prof. W. Brown, F.R.S.
III Plant Growth Regulators	Prof. W. H. Schopfer (Switzerland)	M. A. H. Tincker
IV Toxicology of Crop Protection Substances	Dr. R. Poutiers (France)	Prof. G. Cameron, F.R.S.
V Methods of Application	Dr. J. G. Horsfall (U.S.A.)	J. E. Hardy
VI Analytical Methods and Standardisation	Prof. R. Mayne (Belgium)	H. Martin

In all 94 papers covering subjects under the above heads were presented to and discussed at the meetings. In addition lectures to the full Congress were delivered by Dr. Ernest Gram on ' Factory, Forum and Field ' ; by Prof. J. H. Burn, F.R.S., on the ' Poisoning of Crops ' ; by Dr. Ferdinand Beran on ' The Effect of Oil Sprays ' ; by Dr. Julio de Soto on ' Problems of Locust Control in La Plata ', and by Monsieur J. Faure on the ' Application of Synthetic Organic Insecticides in Fruit Cultivation in France '. A number of tours, visits and demonstrations were arranged including the laboratories and experiment stations of Messrs. Pest Control Ltd., at Bourn, Messrs. Plant Protection Ltd., and I.C.I. at Fernhurst, Messrs. F. W. Berk, at Tilgate, Messrs. Boots Laboratories, at Nottingham, Messrs. Murphy Chemical Co. and the Experiment Stations at East Malling, Long Ashton and Rothamsted.

The opening session was held at the Royal Institution, Albemarle Street, when Lord Bledisloe delivered his presidential address.

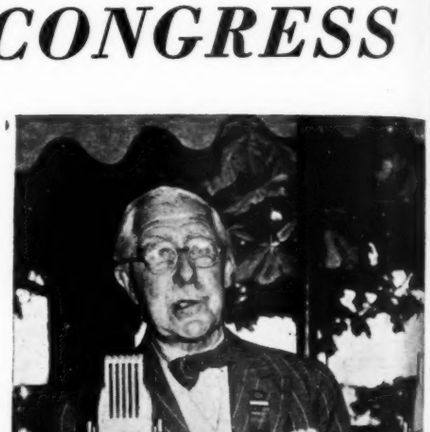
Lord Bledisloe's address

In the course of his address Lord Bledisloe referred to the enormous losses suffered as a result of the ravages of pests and diseases of crops. They had been stated by some to be as high as 50% of the crops grown, harvested and stored ; even if this figure was regarded as excessive he thought that at a conservative estimate they could be placed at 30%, excluding losses due to weed competition.

The authorities of F.A.O. had stated that the total annual losses of grain crops in the world as a result of pests and diseases amounted to 65 million tons, while the late Dr. Scott Robertson had pointed out that if they could be reduced by only 10% it would make available an additional 6½ million tons of grain annually which would go a long way towards alleviating some of the more acute shortages of food in many countries.

In the United Kingdom alone the annual loss from potato blight was estimated to be 10% of the total crop, and even after the crop had been harvested there was a further loss in the potatoes stored in the clamps which, on the average of the last eight years, amounted to 8%.

It was frequently assumed that the present world shortage of food stuffs was the direct outcome of the war, and that in the not too far distant future matters would adjust themselves automatically and there would be a return to the conditions of pre-war plenty. Such an assumption overlooked two facts, one was that even in pre-war days owing to maldistribution of purchasing power large sections of the population were insufficiently nourished, and the other was that in the interval since 1939, the population of the world had increased by 250 million, while world standards of living were also rising. In consequence there was an urgent need to increase production and to reduce avoidable losses.



Viscount Bledisloe speaking at the luncheon at Fernhurst during the demonstration by Imperial Chemical Industries Ltd. and Plant Protection Ltd.

It seemed curious that in these circumstances far too little attention was still paid by the majority of farmers to crop protection. Every good farmer realised the advantages to be derived from manures and fertilisers, but few appreciated that gains equal to those derivable from fertiliser applications could be obtained by the judicious use of weed killers and other methods of crop protection.

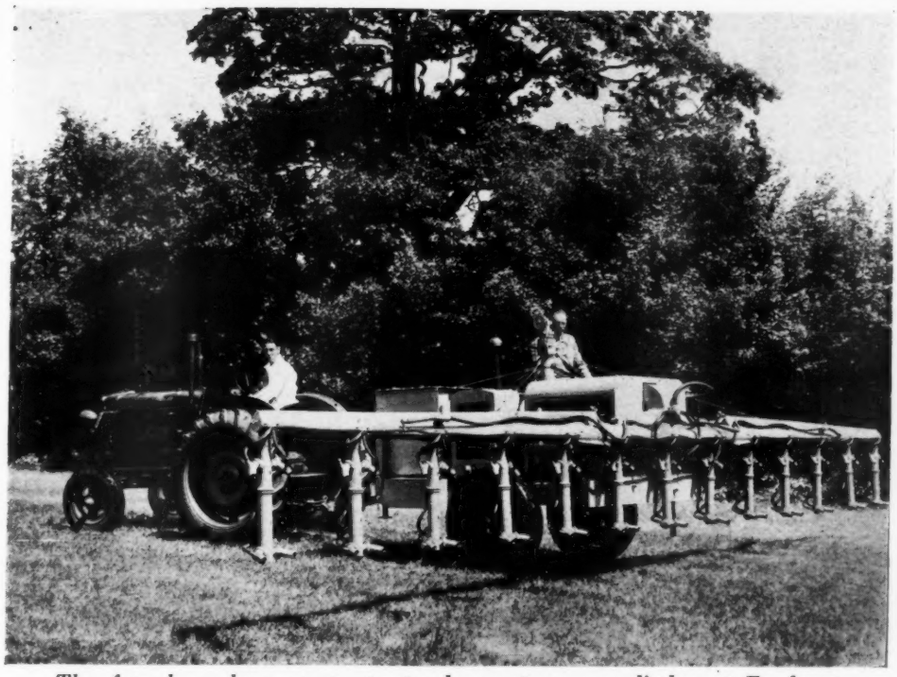
Overseas the position was the same ; it was true that in some cases spectacular success had been achieved, a notable instance was the manner in which it had been possible to combat locust outbreaks by the use of benzene hexachloride, but in other cases large losses, many of them preventable, occurred. As examples could be cited the formidable losses suffered by the Australian wheat industry as a result of fungoid disease, in Italy one-third of the olive crop was lost as the result of pests, while in West Africa the only available means of combating the virus disease

which attacked the cocoa crop was the wholesale destruction of trees which were still in bearing.

It was universally agreed that to meet the world's needs there must be increased production ; this could be secured in some cases by increasing the areas cultivated, but in many countries the majority of the good cultivable land was already under cultivation and the chief hope in increasing the yield per unit area by intensified husbandry. This, however, was insufficient unless it was accompanied by adequate measures to protect crops from losses from pests and disease.

Crop protection must moreover not be thought of merely as the protection of the growing plant. Some of the greatest losses occurred among stored products after the crop has been reaped. The work of the Pest Infestation Branch of the D.S.I.R. had shown how large these losses had been in this country ; overseas they were even larger particularly in some of the African and Eastern tropical countries, owing to infested warehouses and infested ships. The percentage of infested ships coming from African ports was particularly high.

During and since the war knowledge concerning methods of control had greatly extended. Research had brought to light a large number of new substances which could be used in control of pests and diseases, new methods of application had been devised and great improvements introduced into those previously practised. Research had done this and much further research was needed. There was, moreover, especial need that new methods should be explained to cultivators and their value and practical utility fully demonstrated.



The Agro low-volume 13-row tractor-drawn sprayer on display at Fernhurst

There was at present a tendency for research to be concentrated upon purely chemical methods of control. This was, perhaps, understandable since the chemical industry was probably better organised than any other branch to prosecute it while from the purely commercial point of view there were obvious inducements to find manufacture and market products likely to command a ready sale.

It must, however, be remembered that biological and physiological methods of control were of equal importance, and might in some circumstances be preferrable to and more effective than purely chemical methods. In particular the use of parasites and predators on insect pests, physiological conditions as influenced by soil and water conditions and particularly the breeding of disease resistant strains of crops making use of inherited characters, all offered enormous possibilities and had already demonstrated their value in many cases. From the point of view of international food supplies if for no other reason it was essential that adequate funds and resources should continue to be available for research on these aspects.

The preventable losses of crops and crop products owing to pests and diseases were of staggering size and presented an epoch making challenge to science. The question was whether scientists were prepared to accept this challenge and thus ward off from the world a worse calamity than might occur from the use of the atom bomb. The answer from scientists must undoubtedly be ' yes '.

The Autoblast duster and sprayer in action at Fernhurst

Discussions in the sections

It is impossible within the space available to review in any detail the wide range of subjects covered. All sectional meetings were well attended, the discussions were full and, in some cases, lively.

Particular interest centred on the joint

A fruit and hop duster demonstrated at Plant Protection research station Fernhurst

meeting of Sections I, IV and VI, which discussed the chemistry, uses, hazards and methods of analysis of the new organophosphorus insecticides, E 605, Parathion and other related compounds. New information concerning the use of compounds of this description appeared including their use for direct application and as systemic insecticides. Some organic phosphorus compounds are effective fumigants or contact insecticides, but those acting systemically may not show high contact activity. System action appears when the insecticide is added to the soil or culture solution. Many compounds are also phytotoxic and the insecticidal dose may be near the phytocidal dose.

The physiological action of the newer insecticides on insects also received considerable attention particularly in regard to the halogenated derivatives of which D.D.T. and Gammexane are outstanding examples. The subject remains obscure but it seems that action is associated with the nervous system.

In Section II particular interest attached to the use of chemotherapy for controlling plant disease which may react on *e.g.* virus diseases by inactivating them or by preventing the virus from multiplying, on fungus or bacterial pathogens by direct toxic action, by preventing entry, by preventing reproduction, by neutralising the toxin formed by the organism, or by increasing the resistance of the host.

Section III which dealt with plant growth regulators and their use as weed killers as well as with other substances used for this purpose, and with the employment of growth regulating substances for the prevention of fruit drop, flower drop and similar relations provided a wide range of valuable contributions. A number of papers appeared dealing with the action of M.C.P.A., I.P.P.C. and 2—4 D. in controlling weeds, their relationship to the mineral and nitrogen contents of crops, their effects on mitosis and similar matters. There were several papers dealing with the relationship between molecular structure of this class of compound and their activity, while in a number of cases the need for obtaining detailed knowledge of the action of this type of herbicide was stressed. In relation to the aryl dinitro compounds a point which emerged from work in the U.S.A. was that the new compound D.N.B.P. gave promise of being an effective weed controller in clover and lucerne.

Possibly the meetings which aroused the greatest interest were those of Section V, some of which were held jointly with other sections and which dealt with methods of applying insecticides, fungicides and weed killers.

Papers were presented which discussed the application of materials by aircraft, and the relative merits of spraying by helicopter and fixed wing aircraft were keenly debated. Both systems offered advantages in different conditions, when it was desired to cover very large areas in a short space of time fixed wing aircraft had the advantage but they offered some difficulties and for many operations, notably application at low levels, helicopters had many points in their favour. A determining factor is the cost of application. At present fixed wing aircraft are cheaper but as helicopter development proceeds an equalisation of costs between the two will doubtless occur.

Much attention was given to new forms of applicator from the ground. A new form of duster or sprayer in which the dust or spray is passed through a fan was described, and aroused interest. Low volume spraying, for the distribution of small quantities of materials in high dispersion, the use of smokes and aerosols and new forms of spray nozzles were also dealt with.

Among the other subjects considered were the problem of red spider control in greenhouse cultivation and the use of smokes containing azo benzene and other fumigants, the standardisation of insecticides and fungicides, the toxic hazards attaching to some of the newer substances, the use of which had been proposed in plant protection, methods of testing experimentally the efficaciousness of insecticides and fungicides and methods of analysis for such products.

Considerations of space preclude a detailed account of all the numerous visits paid to research institutions but the following call for special comment.

The Research Station of Pest Control, Ltd.

On July 23 the conference paid an all-day visit to the premises of Messrs. Pest Control Limited at Bourn, Cambridge, to witness a display of crop spraying machines. Great interest was shown in the helicopter adapted for spraying crops and trees. Indian delegates said that such a system would be invaluable in India where pest control is almost unheard of.

Nineteen machines of various types were on display. A novel machine was demonstrated for spraying growing cotton, this machine had a seven foot clearance and a 500-gallon capacity. American delegates observed that in many aspects of spraying the United States lagged, and as far as they knew the helicopter was not yet being used on American farms for pest control.

Fernhurst Research Station of Plant Protection, Ltd.

An all-day visit was paid by the Congress to this station on July 26.

A demonstration was given of the performance of 29 different types of sprayers and dusters by the makers, while visitors were able to examine the various machines and products displayed after the demonstration was concluded.

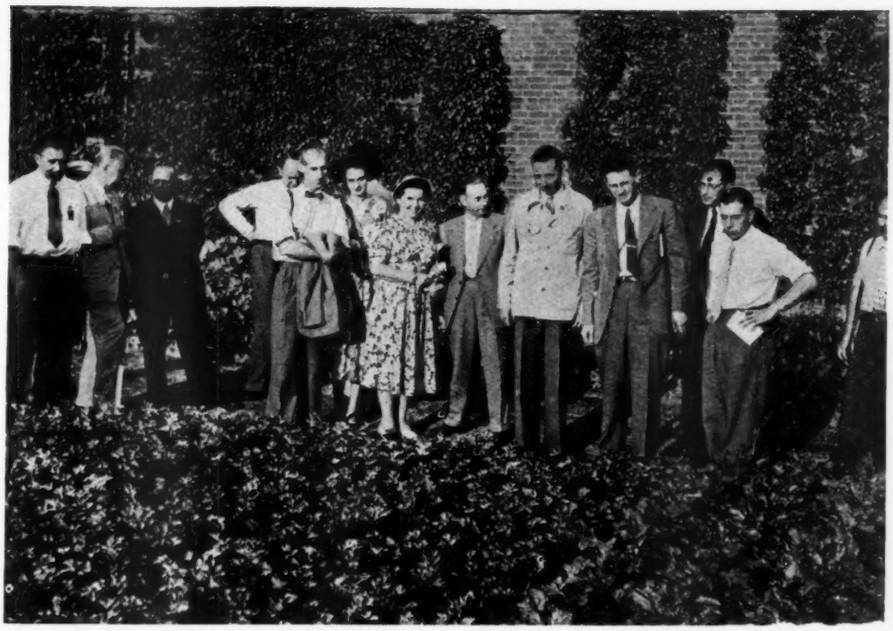
Particular interest attached to demonstrations of the Plantector type of low

volume sprayer, originally evolved at Jealotts Hill Research Station and first described by Dr. W. G. Templeman in the *Journal of the Ministry of Agriculture* in January 1949. The machine allows the applications of weed killers at rates as low as 9 to 12 gallons per acre.

Another new and interesting form of low volume sprayer was the Agro atomiser sprayer suitable for either flat or row crop spraying and giving complete coverage with only 10 gallons per acre.

The Autoblast sprayer and duster also aroused much interest, embodying as it does the new principle of assisting distribution by means of a high speed fan already mentioned. The machine exhibited was designed for use in top fruit orchards and could cover 30 to 35 acres per day ; other types suitable for different crops and smaller types are expected to follow in due course.

As part of the demonstration an exhibit was staged by Messrs. Imperial Chemicals and Plant Protection showing various stages in the evolution of a Plant Protection product.



A group of overseas delegates inspecting crops at Tilgate research station of F. W. Berk & Co., Ltd.

Tilgate Horticultural Station of F. W. Berk, Ltd.

On July 25 overseas visitors to the Congress paid a visit to the Horticultural Station of F. W. Berk & Company at Tilgate. Much of the work there is devoted to research on the use of mercury compounds in agriculture and horticulture of which the Berk organisation is the largest manufacturer. The visitors saw the concluding stages of the work on control of White Rot on onions (*Sclerotium cepivorum*), also work in progress on the use of organo-mercury compounds in soilless culture and on seedlings of tobacco with some possible new applications of mercury compounds as foliage sprays.

Interest was also shown in a new sulphur spray and in work on plant nutrition with special reference to magnesium deficiency.

Grove Farms Ltd., Harwell

An all-day visit to these farms was arranged by the Murphy Chemical Co. on Saturday, July 30. They comprise a representative group of fruit farms and market gardens some 1,200 acres in extent.

Congress members were given demonstrations of the T.I.F.A. fog applicator generating D.D.T. aerosols for the control of insect pests in warehouses and on stored products, of the use of the machine for making thermal smokes for the same purpose, and for spraying in the field. A demonstration was given of the Autoblast machine spraying apple trees, there was also seen in operation the Phoenix Powner system of centralised power spraying by means of the permanent pipe line system installed over 200 acres of fruit trees.

A demonstration was also given of low volume spraying at ground level. On the return journey a demonstration was seen of the use of thermal smokes for treating red spider and thrips on carnations in greenhouses at Arborfield Nurseries near Reading.

The conference dinner

This was held at the Mayfair Hotel on July 27, about 300 were present the guest of honour being Viscount Bruce of Melbourne, who proposed the toast of the Congress. In doing so he emphasised the importance of the losses sustained by crops as the result of attacks by pests and diseases and the need for more exact and detailed knowledge of their magnitude. He thought that attention should be concentrated on obtaining this and that although the task would be difficult, did not consider that the obstacles need be insuperable.

Helicopter spraying potatoes at the demonstration by Pest Control Ltd.

The closing session

At the closing session held on July 28 at the Royal Institution, the chairmen of the various sections presented reports on the work accomplished and the President briefly reviewed the work of the Congress as a whole. The results had been valuable and fully justified the hopes entertained.

Resolutions were adopted expressing appreciation of the work of the Executive Committee in organising the Congress and of the assistance rendered by the Society of Chemical Industry.

On the invitation of the French delegation it was decided that the next Congress would be held in Paris in 1951.

Science and the Soil

At the 68th Annual General Meeting of the Society of Chemical Industry held recently in Manchester, Sir David Rivett, K.C.M.G., M.A., D.Sc., F.R.S., of the Australian Council for Scientific and Industrial Research, stressed during his presidential address the essential interlinkage of scientific effort on behalf of world food production. The following is an extract from Sir David's address.

YOU have all read, I expect, or heard of Prof. Vogt's book, 'The Road to Survival'. It may be unduly alarmist ; I do not know. It certainly is alarming. So are the carefully reasoned pleas of Lord Boyd Orr, of Viscount Bruce, and of other leaders whose work in the Food and Agriculture Organisation of the United Nations has led them to give blunt, plain warnings to the world of what lies ahead if the ratio between population and sound food supply runs away from us. By 'sound' food supply, I mean food production by methods that will not, by their very nature, reduce capacity for further production ; for example, by causing steady loss of soil and destruction of soil fertility.

From the southern Dominions we can look at this food problem calmly ; we do so, far too calmly and selfishly. Yet we are deeply concerned with its solution. We carry a moral responsibility on which I need not enlarge ; and that responsibility falls heavily on our own chemists, but cannot be carried by them alone. You, too, people at our antipodes, are vitally concerned, and the word 'vitally' can be taken literally. Time is a factor that must not be overlooked.

You know of the efforts that are being made at present to increase food supplies from Australia to this country and Europe, let alone to Asia. You may have heard of plans for large-scale conversion of vegetable protein and carbohydrate into animal protein and fat in the northern parts of Australia. You may have been given a delightful picture of unused grass growing waist high down there over huge areas. So it does—usually for three months out of twelve. For the remaining time there is relative famine for the herbivorous chemical converters—the sheep and the cattle. Storage of water and irrigation are cited at once by wet-season visitors as the solution. Yet every chemist knows that water and soil do not themselves, even under right temperature conditions, suffice to yield nutritive pastures. There may be abundant apparent feed in these regions and yet cows will fail to maintain weight and condition as soon as there are added the strains of pregnancy and lactation. It is a situation that calls for biochemists of a high order of ability ; political and commercial magnates will not deal adequately with it. Indeed, it is a tragic fact that 'practical' improvements, such as additional water supplies, may result in utter devastation of certain types of land. Of that, there is only too much evidence available, indicating that in the past, control has not been in the right hands.

Australia, of course, is a very old country ; its soils over thousands of square miles have been severely leached during millions of years. In the northern tropical areas there is shortage of nitrogen ; and when land carries only a few beasts to the square mile, it is idle to talk of correction in terms of ammonium sulphate or sodium nitrate. Unfortunately, it is not possible to apply the normal method of feeding grasses on nitrogen fixed by legumes, for no legume satisfactorily adapted to these regions has yet been discovered or bred. Nor are we yet even aware of all the handicaps applying to these regions. The planners and the practical men won't find them till too late, or resolve them when found. Chemists and chemical studies have been utterly inadequate to enable us in Australia to meet your very legitimate demands that we should use our land to greater effect in providing food (and fibres) for you and for your near neighbours in Europe, and our near neighbours in Asia.

Time does not permit me to read even the summary of specific examples which I had prepared. I must be content to name just a few.

If, for instance, anyone is looking for an attractive problem on the organic side, one can be provided in south-western Australia, in certain parts of which grave fears are entertained for the future of sheep-breeding. An unforeseen result of the wide spread of the legume, subterranean clover, has been the development of a modified strain which, if eaten by sheep in excessive proportion to grasses, causes rather profound changes in the reproductive systems of the animals. Ewes are unable to carry foetuses to maturity, while with wethers the development of mammary glands presents an unusual phenomenon. That something of the nature of an oestrogen is produced in the clover is a suggestion. The study of it, of the reason for its occurrence, of ways perhaps of preventing its production, is an attractive field for the biochemist.

Then there is the case of tracts of country like the Ninety-mile Desert, of about 2,000,000 acres, at the lower boundary of South Australia and Victoria. Rainfall is good ; soil sandy ; natural vegetation—contemptible. But chemists have shown that expenditure of a few shillings per acre on the appropriate chemicals will enable this useless terrain to develop a carrying capacity of three sheep to the acre.

An important empirical result this ; but we must find out why 5s. worth of zinc or copper or cobalt salts enables us to grow 60 or 70 lb. weight of fat lamb. In the absence of such knowledge, we cannot feel certain of our ability even to conserve our newly-won productive capacity. I have no confidence in the 'practical farmer' as a conservator of agricultural lands. If there is one point that stands out in Vogt's thesis it is the danger that the farmer may become a destroyer. He needs and he must have far more assistance, based on fundamental scientific knowledge, than we have yet doggedly set ourselves to provide for him. Tasks for the chemist and his associates are to be found all over the place.

There is another line of work which I would be glad to indicate in passing. Though I talk in terms of Australia, what applies there is of equal importance elsewhere in the Commonwealth and beyond it. Taking a broad view, Enemy No. 1 of the Australian economy, and hence of its usefulness to you people of these islands, is lack of water. To anyone flying over its huge areas, this fact becomes very apparent, except in rare periods of local flooding such as occurred in southern Queensland and northern New South Wales a short time ago. One-third of the country, say a million square miles, receives in rainfall less than 10 in. a year, and, from an agricultural and pastoral point of view, is just about worthless on the basis of existing knowledge. Another third receives between 10 and 20 in., and life in it, in so far as it is dependent on land productivity, is a gamble. There remain another million square miles with a reasonably adequate and reliable precipitation of over 20 in. of water per annum.

Now where there is direct dependence on

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rainfall it is not only the quantity falling that is significant, or the amount lost by evaporation ; the distribution and time of fall matter greatly. So do you wonder that we are deeply concerned with the possibilities of controlling precipitation, or at least influencing in some measure both the time and the place of downfall ? I know that any effort to do this is sometimes described as fantastic ; but is it ? No one can yet say. It is at any rate a fact that our understanding of what goes on in clouds is very far from adequate. That rain can be precipitated from clouds of a particular type, which would not yield it without interference, is a fact of experiment ; but you will not need to be told what an amount of work by physicists and chemists remains to be done before we both understand, and, in some circumstances, influence natural phenomena of this type and on the big scale.

I shall merely mention in passing the artesian water studies that clamour for attention ; but there is one other aspect of the water problem to which one may draw brief notice. It arises in arids ; area and what an extent of them we have in the British Empire ! As potentially productive regions, either under stimulated rainfall or under irrigation, they present highly attractive questions to the chemist. One need only recall quite simple instances of effects following addition of water to systems in equilibrium in its absence, to realise the possibilities of changes in arid soils that may follow their watering. I remember an occasion, in the Mildura region, one blazingly hot afternoon, when I suddenly came upon quite a large field (or ' paddock ' in our vernacular) covered with what from a distance looked like one of your beautiful winter morning hoar frosts ; a white crystalline carpet over a ploughed surface. Analysis showed it to be nearly pure sodium sulphate. From a complex mixture of clays, gypsum, salt and what not in the soil, quite simple double decompositions accounted for its presence. Block after block of land has been ' salted ' out of production, becoming quite useless. We know a good deal about all this now, and over the years have steadily brought back fertility to numbers of ruined vine and citrus properties ; but the chemistry and physics of these heterogeneous equilibria require keener study than has yet been given to them.

I might easily add to this list of matters worth thinking about and working upon. The point may be taken as clear, that in both fundamental and applied chemistry and physics there is abundant work waiting for people possessing British Commonwealth imagination and zeal. I am obviously pleading for more vigorous joint scientific attack upon our British Commonwealth Domain than it is getting—stimulated by the fact that Australia probably exports more scientific capacity than she imports. Somehow or other, we must make the outlying parts of the Empire more attractive to its bright young men, and others not so young. The sense of individual, personal responsibility for the family heritage must increase. More than that, we must develop the sense of general responsibility for the Empire. You at the centre need us and we need you. How are we to increase the essential inter-linkage of scientific effort ?

United States Technical Help in Colonial Development

A significant and important move in connection with developments in the colonial dependencies is the assistance now being rendered by the United States in providing technical help and advice.

The Secretary of State for the Colonies, Mr. A. Creech Jones, has recently announced that three United States' agricultural experts are to conduct a three-months' survey of farming conditions in East, West and Central Africa.

They are Dr. W. V. Lambert, Dean of the College of Agriculture, University of Nebraska ; Dr. W. A. McCall ; Assistant Chief of the Bureau of Plant Industry, Soils and Agricultural Engineering, of the U.S. Department of Agriculture ; and Dr. Arthur H. Cline, Professor of Soil Science, Department of Agronomy, Cornell University.

The survey, which is part of the Economic Co-operation Administration's technical assistance programme, is being undertaken at the request of the United Kingdom Government. It is designed to help the agricultural and veterinary departments of the East, Central and West African territories in the general field of production and in developing veterinary research, plant pathology and soils science, by finding out how best American technical agricultural assistance can be applied.

The three experts, all of whom have wide experience in agricultural research administration, have already arrived in Africa.

The Secretary of State for the Colonies, Mr. A. Creech Jones, studying maps with the American scientists at the Colonial Office

The project is the second approved under the Economic Co-operation Administration's technical assistance programme to provide U.S. assistance in the development of colonial Africa. An American scientist and an American insecticide expert are now making a survey of conditions affecting the control of trypanosomiasis (African sleeping sickness) and malaria in East and West Africa.

Peak Downs, East Central Queensland, location of the sorghum project

Sorghum in Queensland

THE BRITISH OVERSEAS FOOD CORPORATION'S PROJECT FOR ITS MECHANICAL PRODUCTION

THE Overseas Food Corporation's project for the production of groundnuts in East Africa has attracted wide attention but less is known concerning their more recent scheme for the large-scale growing of sorghum in Queensland, which was started at the commencement of last year.

The object of the project is to produce large quantities of this grain to serve as food for livestock and particularly pigs. As everyone knows, sorghum is extensively grown in many parts of the world for human food ; it is the staple food of large sections of population in various parts of tropical Africa—notably the Sudan, Northern Nigeria and many parts of East Africa ; it is also grown extensively in the West Indies. In parts of North America it is also cultivated as a source of sugar, the stems yielding a juice which contains a high proportion of that substance. Efforts are in progress in the Sudan to grow the crop, using mechanical cultivation, to provide food for the local inhabitants, but so far as we know the present project of the Overseas Food Corporation is the first time which its large-scale cultivation has been attempted as a means for providing food for livestock.

The British Overseas Food Corporation have embarked upon a large scale project in Queensland for the cultivation of sorghum using modern mechanical methods, with the object of producing food for livestock to increase Britain's meat supply. This article gives information concerning the project and the progress made to date.

The intention is to produce the grain both for feeding to pigs in Queensland and also for direct export to England for the same purpose.

Data concerning the feeding value of sorghum grain are not very extensive but R. C. Wood gives the following analytical figures for it.

	%
Dry matter	89
*Protein	10
Oil	4
Soluble Carbohydrate ..	71
Fibre	2
Ash	2
Starch equivalent	74
Nutritive ratio ..	1 to 9

* of which 7% is digestible.

It thus resembles maize quite closely in chemical composition. According to the same authority the average yield of grain is 1,500 lb. per acre, but in low rainfall areas it may not be more than 750 lb. On the other hand if it is irrigated and well manured yields up to 3,000 lb. per acre are obtained.

The straw is about twice the weight of the grain, it is extensively used as dried fodder in various parts of Africa, notably in the Sudan, Northern Nigeria and the

Northern Territories of the Gold Coast.

It is also grown as a green fodder crop and may yield 15,000 lb. to 20,000 lb. of fresh material per acre, a drawback to this is that the plant may contain a cyanogenetic glucoside and cases of poisoning of stock fed with the green material from time to time occur.

It is understood that trials with feeding the grain to pigs are in progress at the National Institute for Dairy Research at Reading, England, and at the Hillsboro Experiment Station in Northern Ireland.

The following information concerning the Queensland project is taken from data supplied by the Overseas Food Corporation.

The inception of the scheme

This scheme was the outcome of an investigation made in January 1948 by a group consisting of Mr. A. J. Wakefield, who led the mission to East Africa and recommended the Groundnuts Scheme, Mr. Frank Hollins, of the Ministry of Food, and Mr. L. A. Plummer, who was to be the chairman of the Overseas Food Corporation then in course of formation. The group went to Australia to look into the possibilities of groundnut production, but came to the conclusion that for various reasons the territories available were not suitable. The scheme then proposed was to grow grains which could be converted into animal fats such as pig meats, and a plan was put forward for the growing of sorghum and the establishment of piggeries to provide Britain with pig meat and pork. The earlier crops of sorghum raised before the piggeries were established would be shipped direct to the United Kingdom for use there as feeding stuffs.

It was suggested that at least 20,000 acres could be cultivated in time for harvesting in May 1949 producing some 10,000 tons of sorghum, and that by the May 1951 harvest 160,000 acres could be under cultivation, with pigs being produced in the proportion of two for every acre under sorghum. The plan proposed that ultimately about 500,000 pigs, on 200 pig units, would be fed from some 250,000 to 300,000 acres of sorghum. Grain sorghum has a feeding value almost comparable to maize, but by itself it is an inadequate ration, and has to be supplemented with a protein-rich food. Pigs do well on sorghum but their food needs to be balanced with protein supplements. So at the same time vegetable proteins needed for feeding the pigs are to be produced by growing lucerne on irrigable land both near the coast and close to the sorghum estates. The largest meat works in Australia, the Lakes Creek Meat Works, situated at Rockhampton, will be capable of providing enough animal protein to feed at least 100,000 pigs.

Where the sorghum is to be grown

Five properties totalling more than 350,000 acres have already been purchased by the Queensland British Food Corporation. They are widely separated but this apparent disadvantage is offset by the advantage that the risk of drought, due to an uncertain rainfall averaging 20 in. a year, may be spread over the area. The territories are all in Central Queensland between Rolleston and Blair Atholl. These flat, rolling, treeless plains were once good cattle country, but the land has been for many years overstocked with sheep and cattle, and the nutritive grasses have been eaten out. The result has been that each year the land was able to carry fewer and fewer animals. Neither public nor private enterprise in the Queensland area seemed able or willing to carry out the large-scale reseeding and the provision of better watering facilities that would have restored the land to full use. The soil is rich, black loam of very high fertility.

The sorghum growing scheme has certain advantages over the groundnut project in East Africa—there is no heavy bush clearing to be done; rail and road facilities are good, a state organisation is available to improve and build roads; there are small but reasonably good deep water ports and the territory is free from most of the diseases that exist in tropical Africa.

Progress to date

The site chosen for the first crop was Peak Downs, and here work was begun on May 22, 1948. Pulled by three large tractors twelve disc ploughs began to tear up the ground, turning a combined width of 90 ft. at a time. The original target set was to plough 20,000 acres by the end of October, but things went so well that the target figure was raised to 30,000 acres, and by the end of October this total was reached and harrowing and other cultivations were already well in hand. By December the ground was well prepared for seed and only rain was needed to make a start possible. Heavy rain fell in the early half of January, and after a short wait while the surface partially dried, round the clock planting was begun on January 10, 1949. Speed was essential because the job had to be finished while the soil was suitable for germination. In 15 days 30,000 acres were planted. The sowing was done by 27 tractors each one pulling a large 24-row drill. The work went on day and night, work being done in two 10-hour shifts, with halts for meals, refuelling of tractors and recharging of seed boxes. Despite one brief halt because the ground had dried too much, all sowing was completed by February 12. 29,286 acres were sown with sorghum and a further 225 acres of experimental and nursery plants were sown, including 100 acres of sunflowers.

All the machinery used—apart from Massey Harris and Fordson (Perkins Diesel) tractors—is of Australian manu-

Four of the 27 tractor-drawn machines engaged in planting sorghum on the area covered by the scheme

Combine harvesters reaping the first crop in May 1949. *It is hoped that by May* 1951 *some* 160,000 *acres will be harvested*

facture. And all the labour employed is Australian or recent immigrant labour.

Rainfall has been good and above average and from the first 30,000 acres a harvest of nearly a million bushels of grain sorghum was expected in June which, together with protein supplement, would provide enough grain to feed 60,000 pigs, equal to about 12,000,000 lb. of pork. The first pig farms are being established near Moura on an estate comprising 588 acres where, it is hoped, 200 brood sows will raise about 2,400 pigs to provide a breeding nucleus for other units, with a proportion for slaughter for Britain, and another of 80 acres near Theodore.

Up to the present time the grazing areas have either been left in the hands of the original owners, or have had agisted stock placed on them, but the Corporation is now extending its activities to include the fattening of cattle on its own grazing areas and on the sorghum stubble. The number of cattle purchased this year for short term fattening is about 7,000.

Organisation

The scheme is being conducted by a Corporation set up under an Act of the Queensland Parliament passed in April 1948 the task of which has been defined as 'securing the production and processing of foodstuffs and other agricultural products and the marketing thereof, and in particular the special duty of increasing the supply thereof to the United Kingdom and for other purposes.'

The Corporation is governed by six persons, *viz.*, a Chairman nominated by the Overseas Food Corporation, a Deputy Chairman nominated by the Queensland Government and four Directors, three of whom are nominated by the Overseas Food Corporation and one by the Queensland Government.

Subterranean Clover in South Western Australia

In a series of five papers published in the *Journal of the Australian Institute of Agricultural Science*, various aspects of this fodder crop are discussed.* The plant predominates in Western Australian pastures and many varieties are grown commercially, of which Dwalganup First Early and Mid-Season Mt. Barker are the most popular. The plant is easily established and rapidly builds up fertility. It is particularly valuable as a rotation crop on wheat lands, it is stated to improve crop yields especially on heavy lands, and it is also claimed to improve the bread-making qualities of the flour.

In soil conservation work the plant is of great value as a cover crop in preventing both water and wind erosion.

It is an excellent pasture and forage crop and is stated to improve both health and growth rates in sheep and to reduce lamb and sheep mortality. It possess the drawback that in the green state it may induce sterility in ewes, but this can be partially surmounted by keeping ewes off pastures containing it, and rotating the clover with wheat and oats. Hay made from it is much less toxic than the green clover and can safely be used for feeding to ewes during summer and autumn.

Many problems still remain to be investigated, including the exact role of the plant in building up fertility, the most suitable forms of manurial treatment, the characteristics of different varieties and strains, and the significance of the plant in regard to grass associations in pastures.

* Journal of the Australian Institute of Agricultural Science, 1948, Vol. 14, pp. 119 to 124, abstracted in British Abstracts B III, May 1949.

The Grassland Research Station at Hurley

The new Grassland Research Station at Hurley marks an important development. The intention is that it will ultimately replace the station at Drayton, Warwickshire, which, owing to its remoteness from an advisory centre or a university agricultural department suffered from certain disadvantages.

The Station, which covers 500 acres, will be administered by a governing body known as The British Society for Grassland Research, and its activities embrace Scotland as well as England and Wales. The Director of the Station is Dr. William Davies, the present Director at Drayton, and the intention is that as the experiments in progress at Drayton terminate the work will gradually be transferred to Hurley.

Hurley is close to Reading University, which has a very active agricultural department; it is in a low-rainfall belt while the soil is clay with flints overlying chalk, and is typical of large areas in Southern England.

The terms of reference for the Experiment Station are to carry out grassland research over the widest possible field in collaboration with other institutions. The ultimate intention is that 150 acres should be devoted to critical small-plot experiments on herbage and animal agronomy, while 350 acres will be devoted to larger plots approximating to conditions in practical farming.

Colonial Development

THE recent debates in the House of Commons and the House of Lords on the new Colonial Development and Welfare Act provided some interesting points. The Bill raises the ceiling of expenditure from Imperial Funds in any one year to £20,000,000 on general schemes and to £2,500,000 on research. Twenty-one colonies have now submitted their 10-year Development Plans and some others have been delayed because of special circumstances. Altogether schemes totalling £200,000,000 have been approved of which £135,000,000 were contributed by Colonial Governments and £64,000,000 by the Imperial Exchequer.

In the second reading in the Commons, Mr. Creech Jones referred to the criticism that there has been a tendency to over-emphasise social as against economic schemes. He stated, however, that government policy was to discountenance social improvement schemes whenever they seemed likely to outrun the economic means of supporting them. It is welcome news that this principle has been accepted.

Considerable stress was naturally laid on Africa and Mr. Crawley (member for Bucks) emphasised that inertia and ignorance of the native inhabitant made progress slow. He deprecated the tendency to regard Africa as a substitute source for raw materials ; Africa could, if gradually developed, add to our resources, but it had to be done by Africans and progress depended on the rate at which Africans could go. Attempts to go too fast might lead to serious regression. The same view was stressed by Colonel Ponsonby (member for Sevenoaks), who also emphasised the need for altering native customs and practices if the future is to be safeguarded.

In the debate on the third reading in the House of Commons, Mr. Lennox Boyd (member for Mid-Bedford) stressed the alarming deficiencies in professional and technical personnel which must be remedied if development schemes are to be brought to fruition. Mr. Rees Williams (Under Secretary of State for the Colonies) agreed and expressed the intention of appealing to young men and young women to enter the Colonial Service.

In the House of Lords on July 19 the second reading of the Bill was generally welcomed, but Lord Milverton stressed that it was useless to make funds available for development if there was a feeling of uncertainty concerning the intentions of the Government in regard to the Colonial Dependencies. There could be no certain future if the Government was prepared to give to pressure and disorder what it denied to reasonable representation. In his reply Lord Listowel stated that there was no doubt about the policy in the colonies which was that the peoples should achieve ultimate self-government.

The two factors of shortage of staff and uncertainties as to the future probably weigh at the present time more powerfully than any others in determining the course of future developments.

In regard to personnel, it is no use being sentimental and the fact must be faced that if technicians and scientists are to be attracted to the Colonial Dependencies, conditions must be such as to outweigh the counter attractions of openings in more developed and more settled parts of the world, and to compensate for the inevitable drawbacks which attach to life in remote and often climatically difficult territory.

In regard to the second point, while no one will disagree that the ultimate aims should be to encourage the aspirations of the colonies to self-government, attempts to accelerate the pace unduly must carry with them the possibilities of failure and disaster. The not inconsiderable development which has taken place in the colonies in the past is the fruit of introducing law, order and settled government where they did not previously exist.

The Late Sir Frank Stockdale

The sudden and unexpected passing of Sir Frank Stockdale, G.C.M.G., C.B.E., Vice-Chairman of the Colonial Development Corporation at the comparatively early age of 66 removes an outstanding figure.

He was recognised as a leading authority on agriculture in the Colonial Empire and in the tropics generally. He began his colonial career as mycologist in the Imperial Department of Agriculture for the West Indies and successively held the posts of Assistant Director of Agriculture in British Guiana, Director of Agriculture, Mauritius and Director of Agriculture, Ceylon. In Mauritius he was the first Director and inaugurated the Department, while in Ceylon he completely reorganised the Department and placed it upon the footing it now occupies.

In 1929 he was appointed Agricultural Adviser to the Secretary of State for the Colonies, a post which he occupied for the next 11 years, during which time he visited practically every Dependency and played a leading part in organising the Colonial Agricultural Service and in the great expansion in this respect which occurred during that period.

In 1940 he assumed the post of Comptroller for the Development and Welfare in the West Indies which was constituted as a result of the recommendation of the West Indies Royal Commission 1938-39. As such he was charged with the administration of the grants in aid of the development of the West Indies Colonies of £1,000,000 per annum provided by Parliament under the first Colonial Development and Welfare Act. In his work he was assisted by a staff of experts in agriculture, public health, education and other branches of social service. The task was a difficult one and he discharged it with great ability and considerable success being given the difficult circumstances and the wide variety of interests concerned.

In 1945 he returned to England and assumed duty as Advisor on Development and Welfare at the Colonial Office in which post he was concerned with the formulation and organisation of the many schemes for development in the Colonies proposed under Colonial Development and Welfare legislation.

Last year he was appointed Vice-Chairman of the Colonial Development and Welfare Corporation which was organised for carrying into effect projects for colonial development under the act referred to.

About the same time he assumed the Chairmanship of the Governing Body of the Imperial College of Tropical Agriculture of which he had served as a member for many years.

In this necessarily brief sketch it is only possible briefly to outline his career. He was remarkable for his profound knowledge of agriculture in all its aspects and especially under tropical conditions ; he was possessed of great administrative ability, wise judgment and sound practical common sense and with all these qualities he combined great personal charm.

His achievements were many and his capacity for work unbounded. By all who, like the writer, were privileged to work with him he will be remembered not only as a great administrator but as a friend whose kindness, sympathy and tact could always be relied upon. His death leaves a gap which cannot easily be filled, while his many achievements will be long remembered and will continue to bear fruit for many years to come.—H.T.

Fertiliser Placement

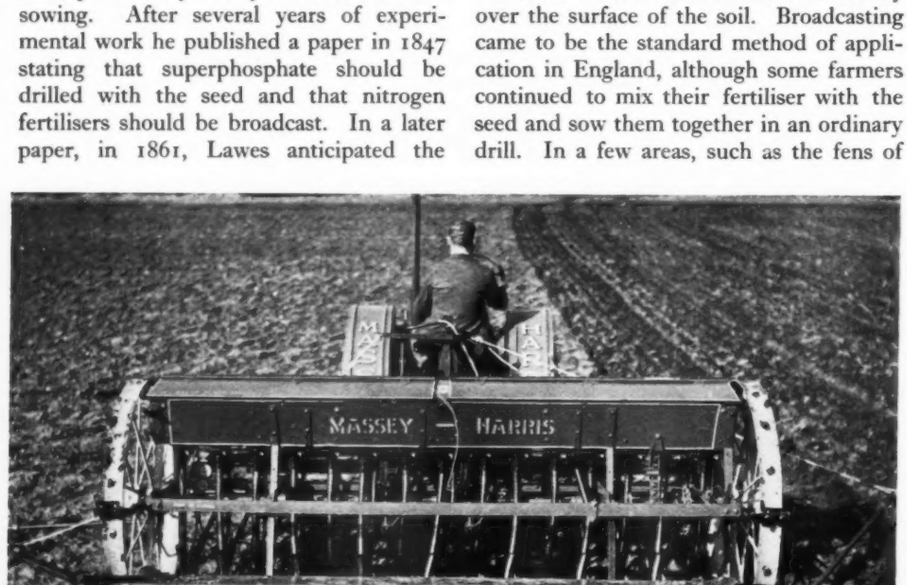
G. W. COOKE, B.Sc., Ph.D., A.R.I.C.

Chemistry Department, Rothamsted Experimental Station, Harpenden, Herts.

The efficiency of plant foods is influenced by their form and the way they are used. Fertiliser may be incorporated with the soil by spreading it on the surface before ploughing, or again it may be spread after ploughing and worked into the soil while preparing the seedbed. A third way, which is referred to as fertiliser placement, is to restrict the fertiliser to bands in the soil near to the seed. This article summarises the value of placement and describes the advantages which may be obtained from localised applications of fertiliser for crops grown in Britain and in other countries.

WHEN fertilisers were introduced in the first half of last century they were often sown with the seed in ordinary drills. J. B. Lawes, at Rothamsted, found that this method of applying superphosphate improved its efficiency for turnips; nitrogenous manures damaged germination, particularly if dry weather followed sowing. After several years of experimental work he published a paper in 1847 stating that superphosphate should be drilled with the seed and that nitrogen fertilisers should be broadcast. In a later paper, in 1861, Lawes anticipated the modern technique of placement in sidebands and suggested that, if mixed fertiliser was to be drilled, 2 or 3 in. of soil should intervene between manure and seed.

Later last century machines were developed in England and other European countries to broadcast fertiliser uniformly over the surface of the soil. Broadcasting came to be the standard method of application in England, although some farmers continued to mix their fertiliser with the seed and sow them together in an ordinary drill. In a few areas, such as the fens of Eastern England, a type of drill was developed for roots with separate hoppers for seed and fertiliser to place a broad band of superphosphate or mixed fertiliser a little below the seed. In new countries, such as North America and Australia, broadcast distributors were never popular and combined seed and fertiliser drills were introduced to allow the maximum acreage to be fertilised and seeded with the minimum of labour by men and horses. It was soon found that fertiliser applied in this way to grain crops was more efficient than broadcast fertiliser, and the method has been gradually applied to most crops grown on wider rows.



(Courtesy: Massey Harris Ltd.

Combine seed and fertiliser drill used for placement of fertilisers

Advantages

For satisfactory growth and full yields crops need an adequate supply of nutrient throughout the growing season. Placed fertiliser may supply nutrient more efficiently than fertiliser mixed with the cultivated layer of soil and under certain conditions modest quantities placed in bands near the seed may give crop yields usually attained only by several times the quantity of broadcast fertiliser.

Placement may improve fertiliser efficiency by reducing the losses caused by leaching or the reaction of nutrients with the soil. Inorganic nitrogen fertilisers are readily leached out of the soil by rainfall whether they are broadcast or placed in bands. Leaching may be minimised by splitting the application. For autumn-sown cereals in Britain only a small amount of nitrogen is needed to establish the crop and any surplus will be leached out by heavy winter rainfall; the bulk of the nitrogen should be applied in spring when growth has started again. Phosphate and potash are not washed out but over a period they react with the soil to form compounds which are useless as plant food. This process of fixation is most serious with phosphates applied to acid soils and is less serious with potassium fertilisers. Fixation may be reduced by placing fertiliser in narrow bands where it will be in contact with much less soil than if broadcast. Potassium fixation is accelerated by alternate wetting and drying such as occurs in the surface soil during the summer and

may be reduced by placement in a zone where the soil is permanently moist.

Plants can take up nutrients only from moist soil, and fertiliser broadcast and worked into the seedbed may be immobilised by drought. Bands of fertiliser placed deeply will keep moist and remain available to the crop for a longer period in dry weather.

High concentrations of nutrients, particularly phosphate, near to the roots stimulate rapid early growth. Such a stimulus is important in helping the crop to overcome attacks by pests or diseases. Extensive early root development promoted by placed fertiliser is valuable where summer drought makes crops dependent on supplies of moisture in the subsoil. Cereals often mature earlier when fertiliser is drilled with the seed and may be fit to cut one or two weeks before crops having the same fertiliser broadcast. Many workers have observed that weeds in crops grown on widely spaced rows are reduced when fertiliser is concentrated near the row.

Placement reduces labour costs when the two operations of seeding and fertilising can be combined. This is of particular importance where large areas of land have to be covered in a short time, as, for example, where seasonal rains allow only a short period for sowing.

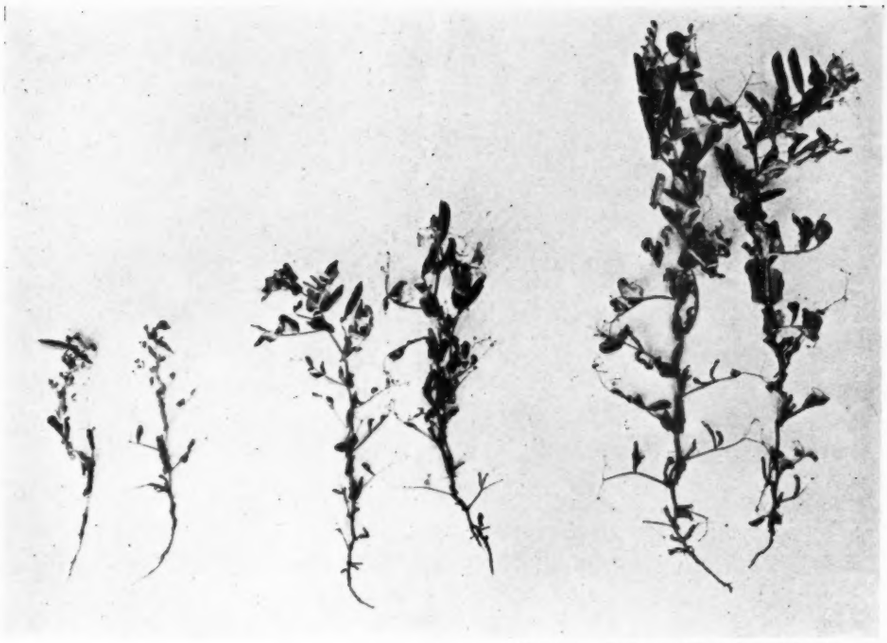
Placing fertiliser near to the seed is often more efficient than broadcasting for crops having a short growing season or a limited root range. Some crops are very sensitive to deficiency of a particular nutrient and may benefit when that nutrient is applied in high local concentrations.

Any or all of these factors may be important in determining the success or failure of placement for a crop grown under any one set of conditions. Fertiliser placement is by no means a universal way of automatically increasing crop yields; where it is introduced for a new crop or into a new area careful field experiments must be made to determine whether there are any advantages over more conventional ways of distributing fertiliser.

Current placement methods

Cereals

Combined seed and fertiliser drills are used for cereals in most dry-farming areas; they provide an excellent means of applying the small quantities of superphosphate which are essential to secure a crop. In England they were used to a small extent before the war but from 1940 onwards large numbers were imported from Australia and the U.S.A. These drills proved very successful for reclaiming poor phosphate-deficient land which was ploughed from permanent grass and cropped initially with cereals.



(*Courtesy : Rothamsted Experimental Station*

Effect of fertiliser (10% phosphoric acid, 20% potash) placement on peas. Left, no fertiliser; centre, fertiliser broadcast; right, fertiliser drilled in pans beside the seed

Experiments were carried out during the war on wheat, oats and barley in England and Scotland. On the average of these experiments half quantities of superphosphate drilled with the seed gave the same increase in yield of grain as the full quantity broadcast; in a few experiments on very phosphate-deficient soils yields from placed superphosphate were several times greater than yields from broadcast superphosphate. On some light chalky soils in Southern England, small dressings of potash drilled with the seed have given a good crop while the same dressing broadcast has been of little value. On less deficient soils, placed and broadcast potash have been of equal value. There is no advantage in drilling nitrogen with the seed for cereals, but it is often convenient to drill a mixed fertiliser containing nitrogen and phosphate. Heavy dressings of fertiliser containing much soluble salts may damage germination and not more than three cwt. per acre should be combine-drilled for cereals.

Row Crops in N. America

Placement for row crops has been practised for many years in the United States and in Canada. Important crops such as maize, cotton, potatoes and tobacco are grown on wide rows spaced 36 in. apart or rather more. Under such conditions placement may be of particular value as broadcast fertiliser lying between the rows may not be reached by the roots until quite late in the season and thus be largely wasted. Although planters fitted with an attachment to place fertiliser near to the seed or plant were introduced last century, placement methods and machines have been much improved since 1929 when systematic field experiments were initiated by a National Joint Committee of the scientific societies and trade associations concerned. Most important crops have been tested and general recommendations issued.

Placement of more than very small dressings of fertiliser in contact with the seed has caused poor germination of most crops particularly when dry weather has followed sowing and this method cannot be recommended. Bands of fertiliser directly below the seed may be beneficial but often cause damage to germination on light soils if heavy dressings are used. Although no one method of placement is superior for all crops and all soil conditions, bands of fertiliser are usually best applied to the side of the seed. Sideband placement rarely damages germination and generally gives higher yields than other methods of application. The bands should be placed a little below the level of the seed and separated from it by at least an inch of fertiliser-free soil. Where heavy dressings are applied the bands are placed further from the seed to lessen the risk of injury. Tests have recently been made with part of the fertiliser worked deeply into the soil and the rest placed beside the seed. Although such split applications have theoretical advantages, experiments have often

(*Courtesy : Rothamsted Experimental Station*

Special seed and fertiliser drill designed for experimental work at Rothamsted in operation

failed to show any superiority over placement of the full dressing of fertiliser in safe positions. For some crops it is best to apply part of the fertiliser beside the seed at sowing and place the remainder in bands beside the rows of the growing crop later in the season, this method reduces losses due to leaching. Recently experiments have tested bands of fertiliser placed deeply in the soil by an attachment fitted to a plough. Such deep placement may be of value where phosphate and potash are rapidly fixed by the soil or where summer drought renders shallow dressings of little value, but a portion of the fertiliser must be applied close to the seed to feed the crop until its roots have penetrated deeply into the soil.

Vegetables

For vegetables American workers have found that some form of band placement is usually the most efficient way of applying fertiliser ; many of the crops, particularly legumes, are very easily damaged by fertiliser placed too close to the seed. The high value of vegetable crops and the need for uniformity and earliness make it important that safe methods should be used ; increased yields and improved quality repay outlay on new machines. Placement for irrigated crops is complicated by the movement of fertiliser salts in the soil water and bands directly beneath the seed or plant may be particularly dangerous.

Recently machines have been developed in the U.S.A. to place liquids deeply in the soil. Aqueous ammonia and anhydrous ammonia have been tested extensively and in 1947 more than 200,000 acres of maize and cotton were fertilised with anhydrous ammonia. It is stated that nitrogen applied in this way produces at least as high yields as the same quantity of nitrogen applied as ammonium nitrate. Anhydrous ammonia is the cheapest and most concentrated source of nitrogen but it could not be applied in other ways without undue losses to the air.

Fruit

Fertilisation of established fruit plantations is difficult as phosphate and potash are held in the surface soil and are not washed into the root zone by rain, while heavy cultivation needed to mix the soil and fertiliser would damage the roots. In Canada this problem has been solved by fixing a fertiliser hopper to a subsoiler and using the machine to deposit bands of fertiliser between the rows of the crop. In other countries a lance has been used to inject concentrated fertiliser solutions directly into the root zone. An immediate response to these applications is claimed.

Placement in Other Countries

There is relatively little published evidence from other countries of the value of placed fertiliser for row crops. In New Zealand, superphosphate is generally applied in a band below the seed for swedes and turnips grown on ridges. In Scandinavia experiments on soils where phosphate fixation is severe have shown that superphosphate drilled in bands gives higher yields than broadcast superphosphate. In Denmark liquid manure from buildings housing stock is placed in the soil by special machines either on bare ground or beside the rows of standing crops.

Row crops in Britain

Experiments in England have shown that for potatoes fertiliser should be localised near the seed. This is achieved quite simply with ordinary planting methods by ridging up the land and broadcasting fertiliser over the ridges when the potatoes are planted in the furrows and the ridges are split, the fertiliser is concentrated in the soil which falls over and around the seed. Fertiliser applied in this way gave as good yields as fertiliser in bands beside the seed. Placement in a band in contact with the seed gave satisfactory yields of potatoes in years with normal spring rainfall but damaged the sprouts, delayed growth and reduced yields when heavy dressings were used in a dry season. When fertiliser was broadcast on the flat land before ridging it was thoroughly mixed with all the soil in the ridge by the subsequent cultivations and gave consistently lower yields of potatoes than fertiliser broadcast over the ridges immediately before planting. Many English potato-planters are designed to work on flat land, planting the seed in a furrow and covering it with a ridge of soil. With such machines, broadcast fertiliser must be applied on the flat before planting and cannot be concentrated near to the seed where it will be of maximum value. Mechanical potato planters working on unridged land should be fitted with an attachment to place bands of fertiliser to the side of the seed.

For other row crops grown on the flat in England the value of placement depends on the type of crop and the fertility of the soil. Sugar beet is not normally grown on very poor soils, it has a deep root system and a long growing season ; experiments have shown that fertiliser placed in side-bands gives average yields of sugar similar to those given by broadcast fertiliser. Swedes have a fairly shallow root system and a shorter growing season ; placed fertiliser gave higher yields in a very dry season when broadcast fertiliser lying in the dry surface soil was probably useless during much of the summer. Peas are another shallow-rooting crop with a short growing period and consistently higher yields have been given by fertiliser in bands to the side of the seed than from broadcast fertiliser. All these crops are sensitive to injury by fertiliser in contact with the seed and bands should be placed not less than two inches to the side.

Where roots are grown on ridges as in Northern and Western England and in Scotland, it is convenient to concentrate fertiliser beneath the seed by opening ridges, placing fertiliser in the furrows and closing the furrows to form ridges on which

the seed is sown. Experiments have shown that this method is superior to broadcasting fertiliser and mixing it with the soil before drawing out ridges.

Machines for placement

Where placement is introduced it is important that the machines used should apply the bands of fertiliser exactly as intended. Combine drills which sow seed in contact with fertiliser should not be used for crops which are susceptible to injury by fertiliser salts. Machines for sideband placement should be constructed so that the relative positions of seed and fertiliser are not altered by wear or by stresses set up as the coulters pass through the soil. The type of coulter used to deposit the fertiliser may vary according to the soils for which the machine is intended but they should not cause undue disturbance of the seedbed or loss of moisture which might reduce germination. Disc coulters may be useful on wet or compacted soils but narrow blades are most successful on stony soils and are not easily blocked by trash in the seedbed.

The fertiliser delivery system should apply the dressing uniformly and the rate should not vary from day to day for any one setting of the machine. If dressings are too heavy fertiliser will be wasted and may cause damage to germination, light dressings may not give maximum yields and irregular distribution gives patchy crops. Machines should be designed to dispense correctly the fertiliser used for a particular crop. Powder fertilisers containing nitrogen and potash are difficult to distribute accurately as they absorb moisture from the air ; the delivery rates of many commercial distributors vary according to the atmospheric humidity and the conditions under which the fertiliser has been stored. With very high humidity the fertiliser may become a paste which cannot flow through a distributor. Poorly conditioned powder fertilisers settle in the hopper. This may increase delivery rates until ' bridging ' in the hopper reduces them. In recent years granular fertilisers have become very popular as they flow freely, do not cake in storage and are not much affected by the weather. Generally granular materials are best for use in placement drills but some types of mechanism originally designed for powders cannot control the rate of distribution of free-flowing granular fertilisers.

Where accurate placement machines are available future practice may tend towards placement of a part or the whole of the fertiliser beside the seed for most crops. The older practice of fertilising only once or twice in a rotation led to loss of plant food by fixation and by excessive dilution with the soil.

Fertiliser placement for barley. Left-hand plot had fertiliser containing 6% nitrogen and 12% phosphoric acid drilled with the seed. Right-hand plot had the same dressing of fertiliser broadcast. Note the much more vigorous growth in the left-hand plot

Fertilisers in East Africa

THE deposits of rock phosphate at Tororo in Uganda, near the Kenya border, which were discovered some years ago, represent an economic asset of great potential value. The development of these deposits has been under investigation by the East African Industrial Research Board since 1945 and they have carried out numerous trials on methods of processing the mineral. As it is an aluminium phosphate it is not susceptible to treatment by the ordinary processes of acid treatment which produce superphosphate and attention has been concentrated upon the production of a silicophosphate by fusion with soda ash, of which, incidentally, deposits exist at Magadi in Kenya.

The low returns obtained from much of the cultivation in East Africa, particularly native African cultivation, has prompted the inception of a very extensive series of fertiliser trials with various crops, and particularly native food crops, under the auspices of the East African Organisation for Agricultural and Forestry Research, which are now in progress.

The development of the Owen Falls hydro-electric scheme on Lake Victoria will make available large amounts of electric energy, and one of the directions in which it is proposed to utilise this is in the production of fertilisers. The first step is that of manufacturing on a commercial scale phosphatic fertilisers, utilising phosphate rock from the Tororo deposits, and the Colonial Office reports that, recently, a technical mission of four experts visited the Tennessee Valley Authority in the U.S.A., which has tackled problems of hydro-electric development and land rehabilitation comparable to those now facing East Africa. It has, in particular, developed large-scale plant for manufacture of phosphates at Wilson Dam, Alabama, and also at Godwin, Tennessee.

A further development which appears practical in view of the inception of the hydro-electric scheme is the production by electrical processes of synthetic nitrogenous fertilisers from the air ; as is well known synthetic processes now account for a considerable fraction of the total nitrogenous fertilisers used in the world, but practically the whole production is concentrated in Europe and North America. The need for nitrogen is on balance the greatest requirement of tropical crops and if the scheme succeeds in providing abundant supplies of nitrogenous and phosphatic fertilisers for use in Africa, a step of the highest importance will have been taken.

New Locust Outbreak Threatens East Africa and Middle East

INFORMATION received from the Colonial Office indicates that East Africa and the Middle East are threatened by a new outbreak of the desert locust.

Swarms from Arabia have invaded the Aden Protectorate (area : 112,000 square miles) and the East African Desert Locust Survey is co-operating with officers of the Aden Department of Agriculture in a thorough-going offensive against them. Should the invasion not be smashed, the locusts may spread into British Somaliland, Ethiopia and Eritrea and thence into British East Africa.

Experts believe that the luxuriant vegetation which sprang up in Eastern Arabia after last winter's rainfall—the heaviest for 50 years—provided sufficient food to enable the locusts to swarm.

Planning the operations is Mr. P. R. Stephenson, Director of the East African Desert Locust Survey.

Motorised parties are being sent to the infested areas. The principal weapon they will employ against the locust swarms will be gammexane, a substance which kills locusts but is harmless to cattle, sheep and camels.

The technique used against the young locusts—the hoppers—is to spread bait (bran) which has been treated with gammexane. The poison is also sprayed from hand-pumps.

A five years' campaign against the desert locust ended only early last year when the 'all clear' was given by an expert conference at Nairobi, Kenya, headquarters of the East African Desert Locust Survey.

In this campaign, mechanised units were sent into all accessible areas where locust breeding was expected : into the deserts of Arabia, into Persia, Eritrea, the Sudan, Ethiopa, the Somalilands and Kenya.

In Arabia, with the help of King Ibn Saud, 300 cars and 1,000 men took the field. Some of the seasonal campaigns in East Africa were waged by as many as 5,000 men with 500 cars.

The five years' campaign against the desert locust cost Britain about £1,000,000 a year—expenditure which was fully justified by the food supplies saved during that critical period. By taking prompt action and using modern methods of destruction, it is hoped to limit the cost of the present campaign to £25,000.

Pivot of the struggle against the three species of locust which plague Africa—the migratory, the desert and the red locust—is the Anti-Locust Research Centre established by the Colonial Office at the British Museum of Natural History, South Kensington.

The centre's funds are provided largely by grants made under the Colonial Development and Welfare Act.

The director is the world-famous authority on locusts, Dr. B. P. Uvarov, C.M.G. The principal scientific officer is Dr. D. L. Gunn.

At this centre there arrives, throughout the year, a constant stream of telegrams from the various 'fronts,' reporting the latest news of locusts. Warning telegrams, based on this information, are sent to threatened areas, enabling the men on the spot to mobilise their forces to deal with any outbreak.

Proposed Authority for the Columbia Valley in the U.S.A.

SO 'spectacularly successful' has been the great project known as the Tennessee Valley Authority in achieving a balanced use of resources through close co-operation between the Federal agencies and the organisations in the individual states, that President Truman, in a recent message to Congress, has urged the inauguration of a similar scheme, to be called the Columbia Valley Administration, for the Pacific North-west area.

This region, which embraces the States of Oregon, Washington, Idaho and Montana, is immensely rich in natural resources. During the past nine years, the population has increased by 37% and the agricultural produce has risen by 25%.

The President, in his message, pointed out that many more acres of land could be reclaimed for agriculture by a system of irrigation as an addition to the 4,000,000 acres at present irrigated. Furthermore, 40% of America's known phosphate reserves lie in the region, and their development demands the closest inter-state co-operation.

In order to make the most of the vast possibilities a co-ordinating body, able to utilize to the full the natural resources, would be of obvious benefit. As President Truman said : 'We have now reached a point where the federal activities in the region require greater integration and the full-time attention of top-level administration if the tremendous potentialities of the region are to be wisely and rapidly developed.'

He proposed that the new administrative unit should be directly responsible for all conservation and development schemes in the region and for co-ordinating all local, state, federal, private and public activities concerned. Such a consolidation, he said, would ensure a balanced programme for dams, irrigation works, power transmission lines and other facilities and provide an efficient scheme for employing them.

The Columbia River is second only to the Mississippi in volume of flow. It rises in Canada and, as the President said, the Administration, by co-operating with Canadian authorities, could shew the world 'new ways of achieving mutual benefit through international programmes of resources development.'

The Tennessee Valley Authority has demonstrated the advantages of over-all co-ordination of activities directed to one object and the extension of this principle to other regions in the U.S.A. appears the logical line of development.

Its further extension to other parts of the world will, no doubt, follow, and there are signs that ideas are already moving in this direction in a number of countries.

Growing seedlings in the T.V.A.'s 147-acre forest tree nursery beside the Church River near Clinton, Tennessee. Pine, locust and other types of seedlings are grown here for use in erosion control work on T.V.A. lands and on co-operative erosion control projects on private farms in the area

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New Plant Research Laboratory

Claimed to be the first laboratory in the world in which plants can be grown under almost every climatic condition under which plant growth is possible, the Earheart Plant Research Laboratory at Pasadena, California, was dedicated recently. It has cost nearly $500,000 to construct and equip and is the gift of Mr. Harry Earheart, a benefactor to the California Institute of Technology.

Crops Grow on Walcheren Again

A. FRANKE and C. VISSER *

In 1944 the Dutch island of Walcheren was flooded by the sea during the Allied attack on the German positions there. It was not until 1946 that it was possible completely to drain the island and to repair all of the shattered dykes. Since then, with characteristic energy, the Dutch have been reclaiming these 15,000 hectares of once intensely cultivated land and restoring its fertility. The work has posed many problems which have been overcome only by the systematic application of scientific principles. At the present time wheat, barley, oats, sugar beet, mangold, potatoes and clover are among the crops successfully cultivated, while considerable areas have been established as pasture. This major operation in land reclamation is described in this authoritative article.

TO enable the allies to make use of the port of Antwerp after September 1944, the island of Walcheren had to be captured as it formed a major base from which the Germany Army could seal off the estuary of the Schelde—the waterway leading to the port of Antwerp. In the end the military operations led to destruction of the heavy dykes which protected the island from the sea.

In October 1944 the dykes were breached in four places and the sea water entered the island, the surface of which is below sea level. With the majority of the German defence works, 80% of the cultivated lands disappeared under the waves. Only the sand dunes along the North Sea and some villages built on higher ground remained dry. The depth of the water was from four to seven feet. Of all the inundated parts of the Netherlands, Walcheren is exceptional as the inundation was entirely uncontrolled. Not only was this island covered with sea water for more than a year, but during that time the sea had free access through the breaches. Owing to the tides which, at this point in the North Sea, show a difference of about three metres, sea water flowed alternately in and out through the breaches with a very strong current. Behind the dykes, a system of deep channels and creeks was formed which stretched many miles into the island and through which a large area of first-class arable land disappeared. To give an indication of the quantities of water that moved at each tide through the breaches, which varied in width from 400 yards to 1,100 yards, it has been calculated that 14,000,000,000 gallons of water passed the barrier twice daily.

Besides the damage caused by the chemical action of the salt water on the soil itself, these movements of water physically damaged the soil. From many fields the very fertile top soil disappeared completely; those which had been ploughed shortly before the inundation suffered exceptionally heavily.

The system of ditches and waterways which is so important for the drainage of the land under normal conditions silted up. The tides brought with them large quantities of sea sand which were deposited on the land, especially around the newly-formed creeks and water channels, sometimes in layers up to four feet thick. Furthermore, all the vegetation on this picturesque island was killed by salt water, and hundreds of farmhouses, barns and sheds collapsed through the action of the waves.

The agricultural recovery

After the dykes had been repaired, Walcheren once more became dry during the first months of 1946, after which the agricultural rehabilitation became all important.

*Of the Zeeland District of the Netherlands Government Service for Agricultural Rehabilitation.

This was one of the most intensively cultivated parts of the Netherlands, and its production capacity had to be restored with the shortest possible delay. The inundated part consisted of 6,000 hectares of arable land, 8,000 hectares of grassland and 500 hectares of market gardens and orchards.

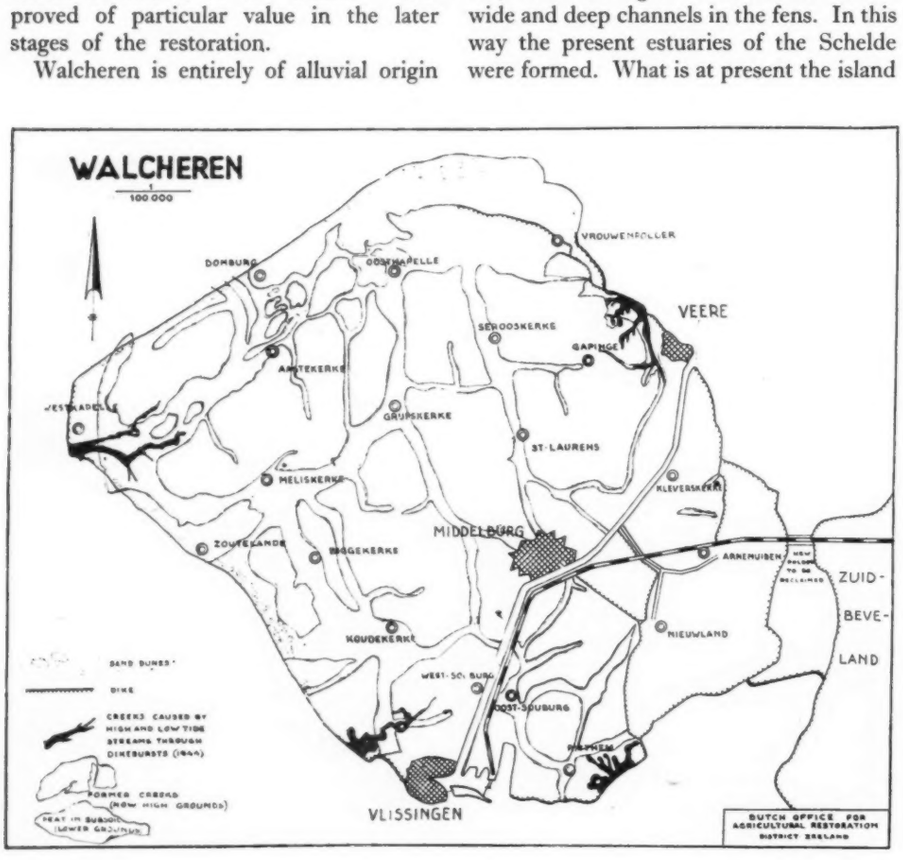
As other parts of the country had been inundated as well, and were liable to be so again, the Government decided on an extensive scientific research programme to find the most efficient methods of reclamation. This proved to be a very wise move. During the experiments and research work many new facts appeared, and a very clear insight was gained into the nature of the problems connected with the restoration of the inundated land as the work progressed.

Mussels on branches of a dead tree after the water had been lowered by drainage

Soil survey

One example of this is the survey of the soil and the drawing of soil maps on agro-geological bases on which are indicated the profile, type, chemical composition, draining capacity and other properties of the soil. As a rule, this research is limited to the top layer to a depth of one metre. The Institute for Soil Survey at Wageningen has surveyed the island of Walcheren along these lines, and it became possible to reconstruct entirely the historical formation of the island. This proved of particular value in the later stages of the restoration.

Walcheren is entirely of alluvial origin and has been built up by the sea. About 2,000 years ago a protective row of dunes stretched from the north of France right up to the north of Holland. Behind this row of dunes lay a stretch of country consisting chiefly of peat fens, through which wound a number of large tidal rivers. Considerable inundations, probably caused by relative elevation of the sea, broke through the dunes and caused wide and deep channels in the fens. In this way the present estuaries of the Schelde were formed. What is at present the island of Walcheren was also intersected by small channels and creeks. These, however, silted up with sand and clay when the sea became calm. It can be readily understood that where these channels and creeks existed, no peat is found in the subsoil.



Clay deposits

On the surface of the peat which remained, the sea deposited a layer of clay which was built up through the ages to a thickness of one to two metres. At the end of this period, approximately a square island was formed which, however, was protected by dunes against the sea only on the north-west and south-west sides.

From about A.D. 800 the inhabitants started to build protective walls along the other sides of the island. As the technical knowledge and equipment was insufficient these walls proved in many cases defective. Many inundations occurred with the same results as have already been described; new creeks and channels were formed which silted up again—a process which repeated itself until the later Middle Ages.

Soil subsidence

The level of the silted up creeks was originally below that of the surrounding land. Gradually, however, the layer of clay on the peat became thicker. Improved drainage followed, with the result that the layer of peat below the clay became compressed and the level of the soil subsided. On the other hand, creeks which had been filled with more sandy material and from which the peat had been washed

The character of the soil over large areas on breaking up after reclamation

away originally, did not subside to the same extent, with the result that the profile of the country became inverted. The original peat became covered with clay and sank below the surface of the former creeks and water channels. This process has been accentuated as, in the Middle Ages, at many places peat was mined to produce kitchen salt after burning. At the moment the highest levels (the former creeks) are used as excellent arable land, while the lower lying lands consist of heavy clay, and, as the undulating surface is difficult to work, is used chiefly as permanent pasture.

Determination of soil quality

The recent soil survey of Walcheren has given an exact map of the various profiles of the island from which, at the same time, the quality of the soil can be determined, which is a great help in estimating the value of each particular part of the island. This is essential for the planned re-parcelling of the land which is already in full progress.

Re-parcelling

Even before 1940 the agrarian situation on Walcheren, by which is meant the lay-out of the land ownership and land use, as well as the size of the agricultural holdings and the type of farming, was found to be unsatisfactory. Owing to the increase in population through the ages, the size of the holdings became smaller and smaller, as the descendants always wished to remain in the same district as their fathers. In this way a large number of extremely small holdings came into existence which did not provide a living for the occupiers, and forced them to work for third parties to enable them to gain a reasonable living and hope of survival.

At present all the farmers have merged their holdings—originally divided into many small fields and widely scattered—from which they will receive, after re-parcelling, useful size holdings in one or a few large blocks which, however, will be of about the same value as the original holding. The value of the original holdings and the new ones can, at the moment, be fairly easily determined with the help of the recent soil survey.

Elimination of salt

Another example of the assistance of science in the reclamation of Walcheren is the salt research by the Laboratory of the Service of the Zuyder Zee reclamation. Inundation by sea water, of course, has disastrous effects on the soil, with the result that the cultivation of crops becomes impossible, and the structure of the soil is spoiled for many years. When large amounts of salt are present no crops at all can be grown. Only when the salt concentration has decreased to a certain extent can crops be grown again.

Experimental fields

During four years experimental fields were established on Walcheren to determine at which concentration of salt various crops could be grown with a reasonable chance of success. It was found that barley and sugar beet were the most resistant crops against salt ; next followed oats, wheat and grass. Pulses, on the other hand, were very vulnerable. It became possible, through the result of these experimental fields, to advise the farmers which were the most suitable crops for their particular circumstances, and most of the farmers kept very strictly to this advice. Nothing was left undone to rid the soil of its surplus salt as quickly as possible. Rain washes the salt away fairly easily, but the first requirement is

Excavator making a drainage channel

that the rain water filtering through the soil carrying away the salt can be drained quickly. This was done by opening up the ditches which had been silted up, and the enormous amount of work this involved is indicated by the fact that in 1946 and 1947 not less than 1,500 kilometres of ditches and watercourses were repaired, partly by hand labour, partly with the help of drag lines by the central organisation, while in addition, the farmers themselves opened up again the water channels through and around their fields, for which they received a grant.

The drainage system was restored almost to its pre-war extent towards the end of 1947, which enabled a very rapid lixiviation of the soil. After a few years the salt concentration in the soil became very nearly normal, with the result that already in 1948 a fair extension of the area cultivated by crops with a low tolerance against salt was possible.

The nature of the damage which salt from sea water causes to the soil comes within the province of soil chemistry. Normally, clay found in Walcheren owes its crumb structure (which is indispensable for the healthy rooting of the plants) to the presence of so-called " calcium clay." The salt (sodium chloride) which penetrates the soil, is in solution separated into sodium and chlorine ions. The chlorine washes away eventually, but a part of the sodium ions replaces the calcium in the soil complex and forms sodium clay which has less valuable properties than calcium clay. The ideal complex of clay, sand and humus particles of the crumb structure disappears, and the single grain structure takes its place, and through the mechanical action of rainfall the crumbs disintegrate into separate particles, which consolidate in such a way that the soil becomes impenetrable. The result is that rain water remains in pools on top of the surface, while during a dry period the surface of the land forms a hard dry layer under which the soil remains in a moist, putty-like condition for a long time. This was the situation which the farmers of Walcheren had to deal with after the sea water had been drained away. They were warned before they returned that deep cultivation of the soil would aggravate matters, while the condition would be worse in relation to the clay content of the soil.

Restoring the soil

Amelioration takes place through the natural action of the climate at a very slow rate, and it is usually only after five to ten years that production attains its former level. During this period farmers would have had to be satisfied with reduced harvests if it was not possible to restore the structure of the soil at a much faster rate through the application of gypsum or calcium sulphate. The Government have, therefore, purchased large quantities of gypsum in Belgium, Luxemburg, France, and as much as was available in Holland itself. Field experiments had shown in the meantime the quantities required to give the optimum results for each type of soil. Calculations proved that Walcheren required a total of 53,000 tons of gypsum, and this quantity has been allotted to the farmers for use on their fields. The exact amount required for each field is determined by the clay content of the land, which was known exactly through the work of the land survey already mentioned.

This procedure has given excellent results, provided the farmers kept strictly to their instructions, and at the moment (1949) we can already say that, owing to the use of the gypsum and the excellent response of the farmers to the advice given, yields of arable crops are back once again to the normal level. Had gypsum not been applied, owing to the deteriorated structure, it would have taken many more years to restore the productive capacity of the soil.

Livestock

Many farms in Walcheren have land on high ground as well as on the lower levels, and these are used as arable and grass land respectively. Therefore the farms are of the mixed type where livestock keeping is relatively more important than the growing of crops. The crops grown on arable land being used, to a large extent, for livestock feeding.

Before 1939 the inundated part of Walcheren carried 30,500 head of cattle. Ravages caused by war-time conditions, the flooding and evacuation were such that in 1945 only 770 milch cows remained in the island. As milk production and cattle breeding were among the chief means of existence of the farmers in Walcheren, the Government has given the highest priority to restoring the cattle population to its pre-war level. The only limiting factor was the speed with which the production of cattle food could be restored.

Grassland

As regards the grassland, the rehabilitation problems are entirely different from those of the arable land. All grass was killed by the inundations, together with all other vegetation, but the old turf still contained a large stock of humus which prevented the deterioration of the structure of the soil. It was found that for grassland no gypsum was required. On the other hand, a quantity of chalk marl was allocated to alleviate lime deficiencies. The Government also issued free all grass seeds required for re-seeding about 8,000 hectares of grassland. Disappointments, however, occurred. The grasslands formed the lowest part of the island where drainage is most difficult and the lixiviation, therefore, slowest. The young grass was smothered in the beginning under a luxuriant vegetation of salt-loving weeds; the severe winter of 1946-47 and the extremely dry summer of 1947 made it necessary to re-seed a large area, but by the spring of 1949 the total restoration of the pastures of Walcheren was to all intents assured, and gradually many

Crops growing on drained and reclaimed land

Hay crop on reclaimed land planted to grass

thousand head of cattle are finding sufficient food there.

The Government, who had undertaken to replace the evacuated and lost cattle on an equitable basis, have taken this opportunity to establish a tubercular-free cattle population on the island. Only completely healthy cattle have been bought for this purpose, while the re-actors which were present have been evacuated, and the Animal Health Service has been charged with the task of maintaining a cattle population on the island free of tuberculosis.

It has not been possible, within the scope of this paper, to discuss all problems of the rehabilitation of Walcheren, but the attempt has been made to show how scientific examination of unexpected problems and planned research have made it possible to find and apply the most efficient methods of solving the difficulties encountered.

Appointments

The Executive Committee of the East Malling Research Station have announced the appointment of **Dr. F. R. Tubbs, M.Sc., A.R.C.S., D.I.C.,** as Director of the Station as from July 1, 1949, in succession to **Dr. R. G. Hatton, C.B.E., F.R.S.** Dr. Tubbs was previously Plant Physiologist at the Tea Research Institute, in Ceylon, and subsequently Manager in Charge of the Horticultural Division of Messrs. Lever Bros. and Unilever Ltd.

Dr. G. W. K. Slater has been appointed Secretary of the Agricultural Research Council in succession to the late Sir John Fryer. He was previously Secretary of the Agricultural Improvement Council.

AGRICULTURAL EDUCATION

Provision for systematic training in agriculture is now accepted as necessary. Unless the means for efficiently disseminating knowledge exist, research can be of little value. An account of some recent developments in different aspects of this question is given below.

EXTENSION WORK

AGRICULTURAL extension is the title nowadays employed to describe the methods by which rural populations are induced to adopt improved farming methods and by which new ideas, new methods and new discoveries resulting from research are brought to their notice and put into practice. It is essentially a form of teaching and differs from classroom instruction in that it is informal and its aim is not so much to do things for the cultivator but to teach people how to do things for themselves.

The task is one of fundamental importance for without adequate and efficient extension service to put the findings of research and their practical application over to the cultivators, research itself must remain largely sterile and unproductive. Agricultural research and extension work are, in fact, mutually complementary.

Extension methods

Extension work makes use of a variety of methods including personal visits to cultivators, meetings, lectures, conferences and demonstrations ; literature in the form of books, journals and leaflets, agricultural shows, the cinema and broadcasts as well as demonstration plots and farms. In fact, the whole gamut of agencies that may be employed is practically endless and includes any device that can be effectively used to bring knowledge to the farmer in a form which he can readily comprehend and assimilate.

Methods must, of course, vary considerably with the community and must be adapted to meet their mentality, the conditions under which they work and live, the crops they grow and the type of agriculture they practice. Success depends on choosing the methods best suited to particular needs.

This is, of course, now widely realised and practically every country which has attained any degree of agricultural development has both research and extensional services. So far there have been but few general discussions of the principles underlying successful extension work and in these circumstances any attempt to give a broad overall picture of the requirements and to describe applications under differing conditions is to be welcomed. On this account particular interest attaches to the report on Agricultural Extension and Advisory Work with special reference to the Colonies, written by Mr. C. W. Lynn and published by H.M. Stationery Office as Colonial No. 241.

Experience in various countries

Mr. Lynn was formerly a Senior Agricultural Officer in the Gold Coast and in 1946 was selected by the Secretary of State for the Colonies to make a tour of certain of the Colonial territories and of a number of other countries, including Great Britain, the United States, Canada and Puerto Rico, for the purpose of examining the extension methods employed and preparing a report summarising the features of the systems adopted in each region with a view to ascertaining and defining methods most likely to be successful under Colonial conditions. The ultimate intention is to establish a lectureship on extension methods at the Imperial College of Tropical Agriculture in Trinidad, where the majority of the senior staff of Colonial Departments of Agriculture receive part of their post-graduate training and the report should serve as a basis for this and should also assist colonial governments in framing their own extension policies.

In his report Mr. Lynn surveys in detail methods adopted in the countries visited and it presents a compendium of valuable information.

Some conclusions

He considers that the basis of extension services must be a country-wide staff of local practitioners serving under regional directors ; plans must be developed in co-operation with the agricultural community which should themselves be organised at all levels to ensure efficient functioning ; the manner of organisation depending to an extent on local conditions and on the community involved.

The somewhat paradoxical point emerges that junior extension staff is in some res-

pects the most important section of the service, since it is on them that direct contact with the farmers largely devolves, and upon their enthusiasm, confidence, patience and personality success largely depends. Too often junior officers fail because they have not confidence in the extension policy ; it is the task of the senior staff to inspire them with this and with the enthusiasm necessary to make their work a success.

Extension must start on a level with the people and carry them forward a step at a time. The basis for an agricultural policy must be facts and not opinions and to provide this surveys must precede extension work to indicate the problem and to show how the answers to them can be geared to local practice. This method of approach is followed in all advanced countries and it is of even greater importance in the colonies where standards of living and education are lower.

Every society is the product of its own environment, which must be understood if extension is to fit circumstances ; programmes must be flexible and continually subjected to review ; indigenous systems are breaking down under new economic stresses and strains and it is only by working in closely with native authorities that it is possible to ensure that the programmes fit the people and that the changes produced by them do not disrupt native communal life.

If, for example, surveys indicate that protective legislation is needed in any particular aspect of agriculture, then it is part of the duty of extension services to educate public opinion to the need for it and to secure the concurrence of the population to its enforcement.

The need for continuity

Continuity of personnel is also vital ; more than enough harm has been done through too early removal of extension officers from one district to another. To meet immediate requirements teams of senior and junior officers should be maintained so far as possible intact for periods sufficiently long to enable results to be secured.

One of the weaknesses in the colonies has been to overlook the significance of uniformity of approach and to tend to build up new organisations for different aspects of extension work, thereby making for overlap and lack of co-ordination ; this, too, needs to be remedied.

Above all, the human factor is important and the right approach must always be employed. " Extension work cannot be blue-printed and carried out by remote control."

It is impossible within the space of a short article to do justice to this excellent report, but it may be safely commended to all who are interested in extension work, no matter to what country they belong.

HIGHER TRAINING FOR AGRICULTURE

AT the meeting of the Royal Society of Arts held in February last, Mr. Dunstan Skilbeck, Principal of Wye College, read a paper on the above subject, of which the following abstract gives the salient points. Mr. Skilbeck dealt primarily with the problem as it presents itself in the United Kingdom but many of the points he raised are of wider and more general application.

An expanding agriculture must make increasing demands for trained personnel since, unless it can achieve a high technical efficiency, it cannot expect to obtain the popular support essential to a stable, long-term farming policy.

Before science began to be applied to farming no provision existed for organised training in agriculture. The craft was handed on by tradition and precept, and it was not until Liebig, Lawes and Gilbert directed attention to the scientific basis underlying farming that the first agricultural college was established in England, in 1845, at Cirencester. A few other centres were established after its foundation, but it was not until 1889 that provision was made from the public purse to provide education in agriculture. The last few years of the 19th century saw the establishment of five University Departments of Agriculture and four new Agricultural Colleges. These were primarily concerned with teaching and research but they were also responsible for extension work.

The weakness of the system was that it was inadequate to the needs of the industry, while there was a natural sales resistance to new ideas and scientific men were often regarded with suspicion.

During the present century there has been development of County Farm Institutes and the number and scope of University Agricultural Departments have greatly increased. During the last two years the National Agricultural Advisory Service has been developed but it is operated centrally and divorced from the teaching centres. There, however, remains an immense amount to be done and there are small grounds for satisfaction. The functions of university education in agriculture are often questioned but in Mr. Skilbeck's view there is no need for justification, provided its role is fully appreciated. The university college cannot produce farmers but it can, and does, provide essential training for men who intend to devote their lives to responsible positions in agriculture. Such men must have really good intellectual equipment, including knowledge of chemistry and biology to a Higher Certificate level, combined with a sound, practical experience of farming. Such a form of training is seldom a valid introduction to research work, but it can induce the critical faculty and stimulate the systematic thought needed in those who control and direct the industry. There is also great need for teachers and extension workers ; while technical administration, both at home and overseas, provides great scope for agriculturists who have received university training in their subject.

Neither a university nor an agricultural college can, however, give purely technical instruction to farm workers, and it is here that the farm institute plays an important part ; the ideal would be to make it possible for every young farmer and farm worker to have some technical training. One of the difficulties is that some resent being sent back to school but Mr. Skilbeck felt that practical experience is an essential requisite before entering farm institute classes.

He also considered that there is a great need for apprenticeship schemes in agriculture which could raise the dignity of agricultural employment and give to trained individuals better prospects and also ensure a supply of skilled and trained workers to the industry. Practically all admit that practical experience in farming is an essential part of training, whether it be at an institute, at a college or a university, but there are many difficulties. Few farmers are anxious to take wage-earning students, accommodation is often difficult and the educational value of a year on a farm varies greatly with the personality of the employer. He suggested that some form of association of approved farms, with teaching institutions, might produce good results.

He regretted the present tendency to over-centralise agricultural training. He thought it was important to preserve local characters and to retain strong local interests in the management of teaching institution. The farm institute should, for example, be the agricultural focus for its locality. He concluded that organised training for farming was the best means of establishing national agriculture on a sound basis and bringing back real prosperity to the countryside.

PART-TIME INSTRUCTION IN ENGLAND

A PARTICULAR aspect of extension work is providing part-time instruction for farm assistants, horticulturists and so on, and the recent interim report of the Advisory Committee under the chairmanship of Dr. Thomas Loveday, appointed by the Minister of Agriculture and the Minister of Education, reviews the position in England.

Third report

The report is the third in the series issued by the committee. The first, published in 1945, dealt with courses in secondary schools and the second related to agricultural and horticultural institutes and was published in 1947.

The agricultural training scheme introduced in 1945 catered for men and women released from National Service and without previous experience who wished to enter the agricultural and horticultural industries.

The report reviews the agencies available for this work and concludes that the provision is far from adequate.

The committee draws a distinction between immediate needs arising out of the agricultural expansion programme and others which are less urgent.

The immediate needs are for instruction in practical skills, including care and maintenance of farm machinery and specialised courses in various branches of livestock production.

Co-operation

In their recommendations the committee stress that authorities must make full use of part-time instructors and insist upon the need for co-operation with the various agencies and with the industries generally. They recommend that local educational authorities should review the requirements of their areas for instruction and provide accordingly. They recommend also planned reading courses for students unable to take formal courses of instruction and the award of certificates of proficiency for pupils on the basis of assessed examinations. They stress the acute shortage of instructors for institutional training, a shortage which in fact is practically universal throughout the world and which must be met if progress is to be achieved at the desired rate.

The report is worthy of careful study by all who are interested in extension activities.

EARLY MAIZE CROP IN THE U.S.A. *In parts of the U.S.A. the maize crop is reported to be very early this year. There is an old Iowa farm saying that 'corn should be knee-high on the 4th of July.' This picture, taken late in June, shows how far this standard has been exceeded in places*

New Marketing Boards for West African Produce

A recent statement issued from the Colonial Office indicates that the West African Produce Control Board is being wound up and that a number of separate boards are taking over its functions.

During its existence of nine years it handled the cocoa, groundnuts, palm kernels and palm oil exports from the whole of British West Africa and during the latter part of the war from Free French West Africa as well. Since its inception, up to March 31, 1949, its turnover amounted to about £225,000,000, while it purchased the following crop tonnages :

	British W. Africa	*French W. Africa*
Cocoa ..	2,200,000	150,000
Groundnuts and beniseed ..	2,200,000	105,000
Palm kernels ..	2,900,000	185,000
Palm oil ..	800,000	20,000

(*The above figures are approximations*)

To replace the original board, the Nigerian and the Gold Coast Cocoa Marketing Boards were set up two years ago and three other Nigerian Marketing Boards were established in April of this year to handle oil palm produce, groundnuts and other oil seeds, and cotton, the main objects of the three boards being to buy from local producers and sell to overseas markets at world prices. The initial working capital for the two cocoa boards, as well as for the oil palm and groundnut marketing boards, has been provided from the accumulated trading profits of the West African Produce Control Board, the sum of £25,000,000 having been paid to the Cocoa Boards, while £10,000,000 is allocated to the Oil Palm Board and £13,000,000 to the Groundnut Board.

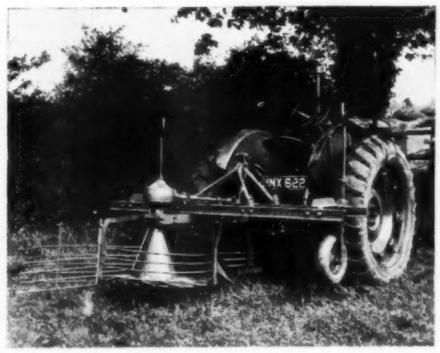
A marketing policy under which these boards were set up, embodying as it does the payment to producers of a fair price for their produce and the setting up of a Price-Stabilising Fund with provision for financing research, has from time to time been subjected to severe criticism, but latterly the board has drawn on its funds to pay producers prices appreciably higher than those at which cocoa is sold on the open market and has guaranteed a substantial price for the next two marketing seasons. In a recent speech, commenting on this, the Governor of Nigeria said, ' Had our marketing arrangements not been in force there is no doubt whatever that producers of cocoa would at this moment be confronted with all the difficulties which sudden drops in income entail and the economy of the producing areas thrown into some confusion.'

Agricultural Machinery at the Royal Show

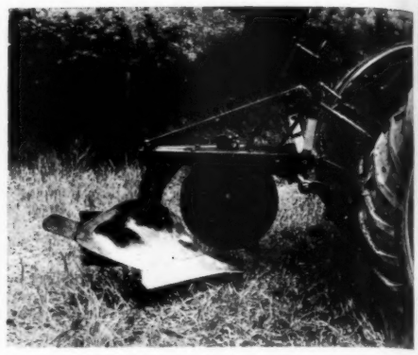
THE agricultural show season is the great opportunity for makers of agricultural machinery to bring new developments to public notice. The Royal Show, which was held this year at Shrewsbury, marks the culminating point of these displays.

British agriculture is now the most highly mechanised in the world and the vast range of machinery displayed on this occasion covered practically every aspect of mechanisation in its application to agriculture and contained much of interest to farmers from overseas.

Each year since the war the number of trade entries has exceeded that of the previous year and 1949 was no exception since they numbered some 110 more than at York in the previous year. The intense activity of manufacturing firms has led to the production of so many competing types in different ranges exhibited that it is difficult often to gauge their respective merits while the number of new devices on show are not always supported by sufficient data regarding field trials. When this has been said, however, one cannot but commend the manner in which the industry is tackling the large number of new problems that present themselves as the result of decreasing supplies of labour. A marked feature was the number of machines which were intended to deal with the specific problems of crops overseas ; thus, for example, a groundnut harvester was exhibited by one of the oldest firms.



Root harvester. *This new Fordson implement is attached to the rear end tool bar by means of ten bolts. It is designed to lift two rows of sugar beet at once with variable row widths. It is power-driven and the spinner head has a speed of 127 r.p.m.*



Single furrow deep digger plough *manufactured by the Fordson Co. Ltd. and Ransome, Simms & Jeffries Ltd. It is designed to bring deep ploughing within the scope of the Fordson Major. It is mounted on the tool bar and is lifted hydraulically.*

Heavy ridging plough. *Tropical conditions often demand specially designed machinery to meet particular needs. In this connection the heavy ridging plough exhibited by James A. Cuthbertson Ltd. and designed to prepare land for planting and replanting sisal plantations is of interest, and attracted many visitors.*

Heavy tracklaying tractor *with extra broad base built and exhibited by James A. Cuthbertson. It is for use on soft lands and is reported to have given satisfactory performance on bog land in Scotland. It is suggested by the makers that it might be useful for mechanical cultivation in rice-growing areas.*

Tool bar equipment

More and more the modern trend favours implements that can be attached to the tool bar of a tractor in supersession of the older type of machine that is towed behind and the majority of the tractors exhibited were provided with tool bars and had hydraulic power lifts for it. A number of new developments in tool bar equipment were seen, including equipment for harvesting root crops as well as for cultural operations. The Fordson root harvester produced by the Fordson Co. and Ransomes, Simms & Jefferies, Ltd., is an example. Another feature was the increasing tendency to provide angledozers and similar equipment for land clearance and excavation for attachment to the front of tractors.

There was a number of exhibits of heavy machinery designed for use with tropical crops, including heavy ridging ploughs for use in sisal and sugar-cane plantations while an interesting exhibit was a heavy, high-powered, broad-tracked tractor designed for use on soft land, which the makers suggested might be found useful in the mechanical cultivation of rice where a frequent difficulty is the bogging down of tractors. It was stated to have been tried out satisfactorily on bog land in Scotland.

Transplanting machines

There was a number of exhibits of transplanting machines. One attached to a tractor, with raising and lowering equipment, attracted a good deal of attention ; in the tropics it might have possibilities for crops like tobacco, which necessitates transplantation. Another exhibit of interest was a machine for interplant hoeing. It is operated partly by hand and an ingenious device enabled its operation in the field to be demonstrated.

The development of recent ideas in regard to the advantages attaching to fertiliser placement naturally led to a wide range of exhibits of combined fertiliser and seed drills ; there was also a number of exhibits of spreaders for farmyard manure ; machinery of this type is gaining popularity in English farming as a result of growing labour shortage and has long been popular on the other side of the Atlantic. There were several exhibits of one-way or reversible ploughs attached to tractors with lifting devices although, in some cases, these were of the single-furrow type, which hardly coincides with the realities of the situation.

Many new forms of diesel tractors

WORLD CROP REPORTS

Auto-gyro sprayer *landing on the roof of the pavilion of Pest Control Ltd. at the Royal Show.*

were also on show, both of the wheel and of the track-laying types. Two new British diesel wheel tractors attracted considerable interest.

Among constructional exhibits the wide range of tubular structural and fabricated work called for notice. Stewart & Lloyds showed, for example, a wide range of products in this class, including tubular roof trusses, screen frames, guard rails and similar things.

There was also a wide range of exhibits of spraying equipment. Possibly that which attracted the greatest attention was the autogyro fitted with equipment for aerial dusting and spraying of crops, exhibited by Pest Control, Ltd. ; the landing of such a helicopter on the roof of the pavilion containing the exhibits of this organisation provided something of a mild sensation.

Statistics Schools in Near East and Far East

An F.A.O. course in agricultural statistics for officers of Near East governments has recently been in session at Baghdad, Iraq. The class consisted of 40 students. T. C. M. Robinson, on loan to F.A.O. from the United States Department of Agriculture, had charge of the three-month training project.

A similar course is shortly to be organised for agricultural census personnel in China. Franklin C. H. Lee, a member of the Statistics Branch of the F.A.O. Economics Division, is in China making preliminary arrangements for the project.

Bananas in N. South Wales

Banana growing in New South Wales is an industry of some importance. Last year the total turnover amounted to as much as £3,000,000 in 1948 while the total crop was estimated to be 2 million bushels. Production is increasing and during the past season 2,700 acres on the north coast were planted with bananas.

Brazilian Oranges

Information supplied by the Brazilian Embassy shows that in 1948 Brazil's total exports of oranges amounted to 2,845,202 cases. In 1939 there were 5,631,943 cases and in 1937, 4,970,858 cases. The year 1939 was a record one for exports, but in 1940 exports were reduced to 2,857,791 cases. In 1938 Europe bought from Brazil 3,569,066 cases and in 1939, 4,230,714 cases. During the war exports to Europe were interrupted. From 1941 to 1944, for example, Great Britain only bought 200 cases from Brazil, and foreign markets for Brazilian oranges were reduced to the Argentine and, on a small scale, to Chile. The recapture of European markets is being made with difficulty, especially with regard to payment. The following figures show the exports of Brazilian oranges in the ten-year period 1939-48 :

Year	*Cases*	*Cr$*
1939	5,631,943	120,186,963
1940	2,857,791	57,200,685
1941	1,949,571	37,711,534
1942	1,281,423	34,052,948
1943	1,341,792	35,379,262
1944	1,271,042	50,639,251
1945	1,396,767	56,664,183
1946	2,768,046	146,731,557
1947	1,703,015	100,972,918
1948	2,845,202	171,224,933

Prospects for Cotton

In the United States trade quarters are forecasting an area under cotton for the coming season up to 10% higher than that cultivated in 1948-49. The yield in 1948-49 was 20% greater than the average for the preceding five years, and the totals of acreage announced as the 1949-50 goal for cotton of 21,900,000 acres is the same as for 1948-49 when 23,600 acres were actually planted.

For Egypt the estimated crop is substantially larger this year, although up to the end of December total ginnings did not reflect it. It is reported that restrictions have been placed on the sales of Karnah and Nemoufi in order to prevent an undue expansion in the production of long-staple varieties in 1949-50. Elsewhere in Africa, which accounts for something less than 4% of world production, it is estimated that production will be substantially above last year, but in South America, south of the Equator, which accounts for about 7% of local production, there is still considerable uncertainty.

There is reason to believe that for 1948-49 the total world production of cotton will be within the neighbourhood of 29,000,000 bales.

Acreage under cotton in Pakistan for the year 1948-49 is 2,911,000 with an estimated yield of 1,046,000 bales of 400 lb. each.

There is a general decrease in the outturn of this crop throughout Pakistan, with the exception of eastern Bengal, where the yield has increased by 28.6%.

The World Pact on Wheat

The world pact on wheat is a major step towards stabilising of trade in that commodity and covers 456,000,000 bushels annually, thus covering half the value of the present world trade at a maximum price of $1.80 per bushel.

Under the agreement the supplies from the principal countries concerned are as follows :

	Bushels
Canada	203,000,000
U.S.A.	168,000,000
Australia	80,000,000
France	3,300,000
Uruguay	1,800,000

The pact is of four years' duration from August 1, 1949, to July 31, 1953, and maximum and minimum prices are fixed for each of the four years. Transactions outside the agreed range of prices will be entirely free, but they will not count towards fulfilment of the contracted amounts by the signatory countries. The signatories to the pact include all the principal importing nations, and all the principal exporting nations except Argentina and the U.S.S.R.

A new International Wheat Council is formed which consists of representatives of all the nations which ratify the agreement. The agreement represents the second international effort to set up a world wheat pact. One was signed in 1947-48 by 36 nations, but never became operative through the failure of a number of countries to ratify it.

World Wheat Production

According to estimates by U.S. Department of Agriculture the world produced a record wheat crop of 5,000,980,000,000 bushels in 1948. This was one fourth larger than the average production for 1935-39 and again occurred chiefly in the U.S. where the crop was 3,651,000,000 bushels. In Europe the crop was slightly below the average figure of 670,000,000 bushels.

The Soviet Union's 1948 crop was unofficially placed at about 135,000,000 bushels, which is about 80% of the pre-war average.

CONFERENCES AND MEETINGS

British Association

THE annual meeting of the British Association is always an event of importance. This year the meeting is of particular interest to all concerned with agricultural questions in as much as it will be held under the presidency of Sir E. John Russell, formerly director of the Rothamsted Experimental Station, who has achieved world-wide fame as a leading authority on all agricultural matters and who incidentally has contributed a foreword to this issue of WORLD CROPS. The meeting will be held at Newcastle-on-Tyne between August 31 and September 7 and the inaugural address will be given by Sir John on Wednesday, August 31, the subject of which will be ' World Food and World Population.'

A feature of the meeting will be a general discussion on problems relating to world population and food production, which will be held on Saturday, September 3, at which Sir John will be supported on the platform by a number of leading experts.

As usual the meeting will be organised in twelve different sections. The president of the section on agriculture is Prof. N. M. Comber and the vice-presidents are Dr. J. A. Hanley, the Duke of Northumberland and Major J. G. G. Rea.

U.N. Conference on Conservation

GREAT interest attaches to the international conference on the conservation and utilisation of resources which will be held under the auspices of U.N.O. at Lake Success between August 17 and September 6.

The conference is to be devoted to the exchange of ideas. Its main task is to be limited to this and it will have no power to bind governments and will not formulate recommendations. Its primary concern is with the practical application of science and the management of resources and, in order to promote common consideration, half of the programme will be given to plenary meetings on subjects of general interest which will examine the contribution of improved techniques to the alleviation of shortages of minerals, fuel, food and forest products.

There will also be sectional meetings dealing with mineral resources, fuel, water, forests, land and marine resources.

From the agricultural point of view the section dealing with land resources is of the greatest interest. The subject heads of this section include matters relating to soil conservation, improvement of soil productivity, cropping and farming systems, plant breeding, protection of crops and grasslands, storage of products and questions relating to livestock.

In each section recognised authorities have been invited to prepare preliminary papers. Among those by whom papers will be submitted on the agricultural side will be :

Dr. C. E. Kellogg
Sir William Ogg
Mr. Mukerjee
Mr. E. S. Archibald
Mr. Sherman F. Johnson
Dr. R. E. Galley
Prof. Virtanen
Sir Harold Tempany
Dr. John Hammond and others.

Congress on Chemical Fertilisers

THE fifth international congress on chemical fertilisers and chemical products useful for agriculture was held between August 4-8 in Zurich under the auspices of the International Centre of Chemical Fertilisers, the activities of which were interrupted by the war. Prior to the war four conferences were held in various places. The present meeting will hold sessions dealing with nitrogenous, phosphatic and potash manures, methods of analysis of fertiliser products for phytosanitary control of pests and diseases, micro elements and herbicides and machines for the distribution of fertilisers.

Record Output of the British Sugar Corporation

The out turn for 1948 of nearly 560,000 tons, in terms of white sugar, was the highest yet achieved by the British Sugar Corporation, and exceeded by 130,000 tons the results of the previous year. In addition, a very large quantity of stock feed — about 3 million tons of leaves and crowns and 300,000 tons of dried pulp, was made available to the growers and 174,000 tons of molasses were produced.

The crop was grown by more than 42,000 farmers on rather less than 400,000 acres, the average acreage contracted being 9.43 acres. The average yield 10.84 tons per acre and the average sugar contained 16.33%. Payments to farmers for beets totalled £23,800,000.

Increased Crop Production Through New Varieties

The production of new and improved varieties of crop probably holds out the best prospect of increasing agricultural yields.

In a recent paper* Dr. F. R. Horne, Director of the National Institute of Agricultural Botany discusses this question, and although it deals mainly with improvement of food crop varieties under English conditions some of the conclusions he draws are of wide general application. They are summarised below.

(1) The strain or variety of a crop plant is of fundamental importance in determining production.

Adaptation

(2) Varieties must be well adapted to the environmental conditions in which they are to be grown if they are to give maximum yields. In some cases they may suit wide ranges of cultural conditions, in others specific strains may be necessary for particular regions. They must also be suited to the requirements of the consumer.

(3) Increases in production are most readily obtained from crop plants by the removal of some factor which limits production. Instances include resistance to disease and in cereal crops resistance to shattering of ears, to sprouting in the ear and to lodging. The latter is of particular importance since it permits the fullest use to be made of fertiliser treatments, and the potential yielding capacity of the variety to be fully expressed.

Poor soils

(4) On poor classes of soils where the law of diminishing return operates to diminish financial returns from high dressings of fertiliser it may be desirable to use varieties which give consistent though lower yields.

(5) The direct increase of productivity as distinct from the removal of limiting factors is more difficult but has been achieved in new varieties of a number of crops.

Cross-breeding

(6) Crosses between different species of crops have enabled notable advances to be made in the removal of limiting factors.

Crosses between widely different species or sub-species however tend to upset the genetic balance. Polyploid varieties, whether derived from crosses between different species, or increase in chromosome number through the use of Colchicine, show similarly disturbed conditions.

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